SCIENCE ABSTRACTS.

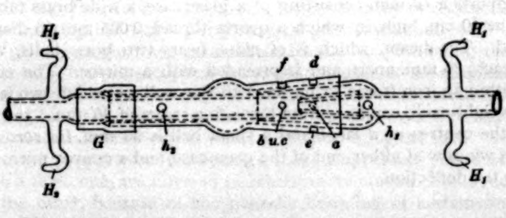
PHYSICS AND ELECTRICAL ENGINEERING.

APRIL 1902.

GENERAL PHYSICS.

634. *The Minarelli Ballistic Pendulum.* **M. Radaković.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 511–518, May and June, 1901.)—This type differs from the ordinary pendulum in that the projectile strikes a hard steel plate. No impression is made on this plate, but the bullet is shivered to pieces. Objection to the pendulum has been made on the ground that velocities obtained by it must be too low. The author points out that after impact the fragments of the projectile fly off at right-angles to their original direction of motion, and proves from this that the velocities obtained are not less accurate than those given by the ordinary form of ballistic pendulum. He remarks that the Minarelli instrument is very suitable for determining the velocity of a shot very close to the muzzle of the gun, and points out the need for experiments on this subject. W. S.

635. *Mercury-sealed Horizontal Stop-cock.* **G. W. A. Kahlbaum.** (Zeitschr. Instrumentenk. 21. pp. 265–266, Sept., 1901.)—This contrivance consists of three pieces, shown in position in the accompanying figure, with conical ends to facilitate close contact. Two of these fit into one another, while a third forms a sleeve enclosing both. Rubber bands round the hooks H_1, H_2 press the parts firmly together endwise, and a piece of rubber tubing is slipped over the join at G. Three holes, *a*, *b*, *c*, are pierced in the piece to the right (*b* and *c* being in the same cross-section), and three corresponding holes, *d*, *e*, *f*, in the sleeve, so that either of the pairs *ad*, *bf*, or *ae*, *cf* can be



made to communicate. In practice, the sleeve is rotated round the right-hand section till the holes *a* and *b* come opposite to *d* and *f* respectively. Mercury is then admitted at one opening, say *ad*, and the air escapes at the other, *bf*. Then the sleeve is rotated through 90°, which closes all the openings. To open, turn the sleeve 90° further, which brings the holes *e* and *f* over *a* and *c* respectively. Air then enters at *ea*, and the mercury escapes through *fc*. Karl Kramer, of Freiburg, Basle, is the maker. A. E.

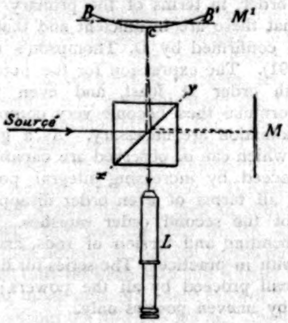
636. *Aneroid Barometers at Low Temperatures.* **H. F. Wiebe** and **P. Hebe.** (Zeitschr. Instrumentenk. 21. pp. 331–338, Nov., 1901. Communicated by the Physikalisch-Technische Reichsanstalt.)—Tests made in connection with the German South-Polar Expedition. Eighteen German, four French, and two English aneroids were tested between +22 and −15° C. at air pressures of 760, 590, and 410 mm. The non-compensated instruments naturally give greater temperature coefficients, and these coefficients increase as the barometric pressure is reduced, also at low temperatures. But the variations in the temperature coefficients are less regular, and may be positive or negative, in the case of compensated instruments, so that aneroids must so far be considered to be less reliable for low-temperature observations than for ordinary work. It resulted, on taking the instruments to pieces, that these sudden irregularities are probably due to the combination of brass and iron in the base plate; base, pillars, and levers should be made in one material only. H. B.

637. *Portable Transit Instrument.* **A. Fennel.** (Zeitschr. Instrumentenk. 21. pp. 326–328, Nov., 1901.)—The instrument, which is made by Otto Fennel Söhne, of Cassel, fits into a box 34 × 26·5 × 26·5 cm., and weighs, with the box, 13 kg. The hard steel rings, with which the horizontal axis rests in the Y bearing, are the only parts constructed of a material liable to rust. The eyepiece can be shifted longitudinally through 2 mm. without turning about its axis; the eyepiece head can be turned through a few degrees, and the hair-cross can be shifted laterally, and easily be replaced. H. B.

638. *Portable Cavendish Apparatus to Demonstrate Mass Attraction.* **M. Kohl.** (Zeitschr. Instrumentenk. 21. pp. 328–330, Nov., 1901.)—A modification of the Boys arrangement, made by Max Kohl, of Chemnitz. A tripod supports a column consisting of a glass case, a wide brass tube, and a narrow one 40 cm. high, in which a quartz thread, 0·005 mm. in diameter, is suspended. The beam, which is of glass, bears two brass balls, weighing 0·75 kg. each, 36 mm. apart, and is provided with a mirror. The column is placed within an iron frame to be fixed to the wall, on which two lead balls, of 3 kg. weight each, can be shifted through a range of 36 mm.; the distance between the centres of a large and a small ball is 53 mm. for zero position. There is a window at either end of the glass case, and a convex mirror outside magnifies the deflection. H. B.

639. *Optical Testing of Linearity.* **G. Lippmann.** (Comptes Rendus, 134. pp. 17–18, Jan. 6, 1902.)—A movable carrier is guided by the sliding base or scale whose rectilinearity is to be tested. A lens is carried in this way to various points, and by it is viewed another coaxial lens fixed in position. The parallelism of the carrier in all positions indicates the rectilinearity required. J. W. P.

640. *Optical Comparator for End Standards.* **A. Lafay.** (Comptes Rendus, 133. pp. 867–869, Nov. 25, 1901.)—The paper describes an arrangement in which Govi's camera lucida is employed in a comparator for end standards, with the advantage that the contact planes are virtual, so that injury from rubbing, hitherto a drawback to the use of end standards, is avoided. L in the accompanying diagram is a telescope, M a mirror, *xy* the Govi cube [see Abstract No. 1415 (1900)], and BB the polished spherical end of the standard rod, which acts as a second mirror. When the plane M′, which is the virtual image of M in *xy*, cuts BB′, a system of coloured interference rings is seen in the telescope. By adjusting the distance of M from the cube, the central white ring is reduced to a spot. The plane M′ will now be tangential to the end of the rod. By means of a duplicate arrangement at the other end of the rod a similar operation is performed at that end also. The positions of the mirrors, which are moved by micrometer screws, are then read off. If the standard rod be removed, and a copy put in its place, the mirrors will have to be adjusted afresh, and the algebraic sum of their displacements will be the difference in the length of the rods. A. E.



641. *Necessity for Postulating an Ether.* **B. Hopkinson.** (Phil. Mag. 3. pp. 123–126, Jan., 1902.)—The author argues that the phenomena of gravity, together with optical and other terrestrial phenomena, fail, with one exception, to give any logical non-metaphysical basis for postulating the existence of an ether. This one exception is the consequence of the undulatory theory, that the aberration of a star depends on the motion of the earth relative to the free ether, and is entirely unaffected by the motion of the star, which, if capable of experimental proof, would give such a logical basis. Now certain stars, known as spectroscopic binaries, though appearing single when viewed through a telescope, are inferred to consist of two components revolving one about the other, because of the periodic doubling of certain lines in their spectra. This would occur, owing to the Doppler effect, when one component of the system is moving towards, and the other away from, the earth. The orbital velocity, which can be computed from the separation of the lines, amounts in some cases to as much as 150 miles per second. If the motion of the components affected their aberration, then, when moving as above, there should be a lateral separation between the components as seen in a telescope, resulting in a periodic doubling alternating with the separation of the spectroscopic lines. The fact that no such doubling can be detected affords, in the author's opinion, very strong, if not absolutely conclusive, evidence that the aberration is unaffected by the motion of the star, and gives a real logical basis for postulating the existence of an ether.

G. W. de T.

642. *Theory of Elasticity.* **W. Voigt.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52. pp. 1266–1269, Dec. 12, 1901.)—After referring to the work of Kohlrausch and Grüneisen [see Abstract No. 271 (1902)], the author considers the bearing of these experiments on his own general theory, stated seven years ago. Expressions for the elastic potential are stated, with additional terms of the third order, in terms of the primary invariants. The new observations show that these are insufficient and that further development is needed. This is confirmed by O. Thompson's observations (Ann. d. Physik, 44. p. 555, 1891). The expression for the potential needs therefore terms of the fourth order at least, and even these are sometimes insufficient. The formulæ thus become very complicated, and methods of successive approximation are necessary. As a general conclusion, all elastic deformations which can be observed are capable of being expressed by series which proceed by increasing integral powers of the applied forces. In general all terms of even order disappear from such series, provided that that of the second order vanishes. This happens in the expressions for the bending and torsion of rods, except in certain cases not commonly met with in practice. The series for linear or cubical dilatation (push or pull) will proceed by all the powers; but for bending or torsion, in general, by uneven powers only. J. W. P.

643. *Barometric Oscillations on the Sonnblick.* **A. v. Obermayer.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 289–333, April, 1901.)—The harmonic analysis is given of fourteen years'—and more particularly the ten years 1887 to 1896—barometric observations on the Sonnblick, 3,106·5 m. above sea-level, with special regard to serene and cloudy days. Pernter's conclusions concerning the barometer at high altitudes are confirmed. The often insignificant morning minimum at 4 a.m. in the plains is well characterised in the mountains and delayed to 5 a.m. in March and June, 6 a.m. in October, and to 6h. 20min. in December and January. The forenoon maximum at 10 a.m. is delayed to 11 a.m. in November and further delayed to 1 and 2 p.m., and later still in summer, receding again after July. The (4 p.m.) afternoon minimum of the plains is of secondary importance on the Sonnblick, while the evening maximum of the plains is the chief maximum on the mountains, and occurs at the normal time, 10 p.m.; it becomes especially pronounced as the season advances from February to May. On serene days the morning minimum and the maximum of the forenoon (or afternoon) are most noticeable, while the afternoon and evening oscillations are less characteristic. On cloudy days the evening maximum is most marked, and the deviation from the mean daily barometer at midnight is much more striking than on serene days. H. B.

644. *Temperature Variations in the Atmosphere.* **L. Teisserenc de Bort.** (Comptes Rendus, 134. pp. 253–256, Jan. 27, 1902.)—Observations made by the aid of unmanned balloons and kites show that the meteorological variations in the vertical may be very rapid and peculiar. Isothermals are

reproduced for the thirty-five days from Jan. 27 to March 1, 1901, for Paris, extending to elevations of 10 and 12 km. This is the first time that such continued records have been secured. There are instances of temperature inversion, ascribed to insulation of the clouds, and of very low temperatures at high elevation above a high-pressure area. H. B.

645. *Meteorological Observations at Moscow during* 1900. **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 4. pp. 397–432, 1900.) — Observations made by the author, director of the University Observatory, Pitschuschkin, and Speranskij. The high barometer of December, 1899, continued to March, 1900, and was followed by an unusually low barometer till June; the November means were abnormally high, those of December low. The diurnal barometer variations are remarkable, especially the high maximum of September and the insignificant minimum of January, February, March, and also June. Daily amplitudes of more than 12 mm. were observed in all the months except July (6 mm. only), but the absolute extremes are not striking. Winds from the N.W. and further S.E. predominated; the Observatory possesses only Wild apparatus, no anemometers. The general course of the air temperature was in accordance with the barometer variations, winter, spring, and summer being all cold; the sky was unusually clouded, and only eight cloudless days (five in August) were reported. The temperature extremes of 3 —7° in December and + 32·6° in July give an annual amplitude of 69·9°, the highest since 1893. July was the only month without frost in those eight years. 596 mm. (533 normal) of rain fell on 196 days, snow on 102 days; thunderstorms occurred only between May and August; 76 cases of solar and lunar phenomena halos, mock suns, &c., were recorded. The soil was never found frozen at depths from 0·8 down to 2·5 m.; observations were made at depths of 0, 0·2, 0·4, 0·8, 1·6, 2·5 m. H. B.

646. *Meteorological Observations at Geneva and on the Great St. Bernard during* 1900. **R. Gautier.** (Archives des Sciences, 13. pp. 55–74, Jan.; pp. 148–181, Feb., 1902.)—The author, director of the Geneva Observatory, includes December, 1899, in his tables, and thus distinguishes between averages for the meteorological and for the civil year. At Geneva, observations are made every three hours from 7 a.m. to 10 p.m.; additional automatic records are obtained at 1 and 4 a.m., and a further evening reading is taken at 9 p.m. to render the tables concordant with those of the Swiss meteorological service, based on observations made at 7, 1, 9—all local time. On the St. Bernard, the brothers take six observations, starting at 5 a.m. during the summer; additional records will be available from the station in the new Hospice building, opened in 1900. The averages of 27 and more years of Plantamour, up to 1875 (Geneva), and 1867 (St. Bernard), are accepted as normal values. 1900 was a warm year, March the coldest month at both stations. The extremes at Geneva were — 9·8° and + 33·9° C., giving an annual oscillation of 43·7° C. against the average 45·8° C.; on the St. Bernard —26·4, March 5, and +19·7°, July 26. The Geneva normal barometer of Noblet is 404·91 m. above sea-level; the Gourdon barometer of the St. Bernard, presented by de la Rive in 1829, is 2,070·3 m. higher up, according to the survey of 1855; the hypsometrical observations of 1900 give a difference of 2,066·7 m. Wind velocities of more than 25 km. (Richard anemograph) were observed thirteen times at Geneva, two maxima of 55 m. occurring on December 9, 1899, and March 31, 1900. The St. Bernard observatory is not well situated for wind studies, and the wind force is estimated on the Beaufort scale. There are thirteen rain gauges in the canton of Geneva; thunder was heard on twenty-five days; the year was wet in both places, and more mist and less sunshine (Campbell-Stokes apparatus) were recorded than usual. H. B.

647. *Diurnal Variations of Atmospheric Refraction.* **V. E. Boccara.** (N. Cimento, 2. pp. 204–211, Sept., 1901, and Memorie della Società Spettroscopisti Italiani, vol. 30, 1901, pp. 162–178.)—The author's observations were made at Catania, on the coast of Sicily. It had been noticed that the sea horizon changed its position relatively to buildings in the city, and this suggested the method followed. By means of a telescope, the height of the horizon was measured with respect to a fixed landmark comparatively near the observer. A curve illustrating the results is given, together with other curves showing the meteorological conditions during the same interval. It is seen that the refraction is a maximum about 8 a.m., decreases rapidly from 8 till 11.30, then remains pretty constant till 3 p.m.; and towards dusk increases slowly again. The mean value was smaller when the sky was clear than when it was cloudy. On the whole the values were small. While no close connection can be traced, it appears that decrease of pressure, presence of aqueous vapour, and increase in difference of temperature between the place of observation and the sea horizon, all tend to increase the refraction. Putting $n = 2(d - d_r)/d$, where d, d_r, are the true and apparent dips, the results give $n = 0{\cdot}1073$, which agrees fairly well with the value $n = 0{\cdot}1026$ obtained by Soler at Palermo in 1899 by a more difficult method. A. E.

648. *Hertzian Rays and the Sun.* **C. Nordmann.** (Comptes Rendus, 134. pp. 273–275, Feb. 3, 1902.)—An investigation at the top of Mont Blanc gave negative results, no such radiation being found. A. D.

649. *Cooling of very Hot Stars.* **H. Kayser.** (Astrophys. Journ. 14. pp. 313–316, Dec., 1901.)—In the spectra of certain stars which show both bright and dark lines of hydrogen, Campbell found that the lines of longest wave-length are always the brightest, and that there is a transition through the spectrum to the darkest, which are those of shortest wave-length, and he considered that these stars are in a state of transition between Vogel's 1a and 1c classes. If e be the coefficient of emission from a radiating body 1 for a certain wave-length, and E that of an absorbing body 2, whose coefficient of absorption is A, then by Kirchhoff's law $E = e'A$, where e' is the coefficient of emission of a perfectly black body at the same temperature as the body 2. Also the body 2 must be colder than the body 1 to render absorption possible, and thus $e > e'$. While the body 1 is emitting the amount e the body 2 absorbs the quantity eA and emits $e'A$, and therefore the total quantity we receive is $e - (e - e')A$. The amount of reversal depends on the relation of $(e - e')A$ to e, and it is quite possible to have the bodies 1 and 2 at such different temperatures that all the spectral lines will not be reversed, but only those in which $(e - e')A$ is large enough. From the emission curves of perfectly black bodies the ratio $(e - e')/e$ is found to be small for long wave-lengths, and to increase to almost unity for short wave-lengths. Therefore, although E, and therefore A, decreases along a series of lines, the change in $(e - e')/e$ is sufficient to cause the reversal of the lines of shorter before those of longer wave-length. In this way the author thinks the temperature of the absorbing layer might be approximately arrived at, as its emission should reach a maximum for the rays of wave-length about equal to those at which reversal begins to appear. He therefore estimates these stars at a very high temperature. E. C. C. B.

650. *Variable Stars of Long Period.* **E. C. Pickering.** (Archives Néerlandaises, 6. pp. 133–136, 1901.)—The article gives suggestions for the benefit of general observers having small telescopes, who, by employing some systematic method of observation, may obtain useful results in the field of variable star work when the periods involved are sufficiently long to render small errors inappreciable. An empirical series of comparisons can be used at first, afterwards transferring to standard magnitudes by reduction by aid of the standards obtainable at several of the large observatories. C. P. B.

REFERENCES.

651. *Theory of Girders.* **T. Landsberg.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 1765–1772, Dec. 14, 1901.)—The author works out several cases of girders with redundancy due to stiffness at the springings and crown. H. R. C.

652. *Psychrometers.* **J. Schubert.** (Phys. Zeitschr. 3. p. 120, Dec. 15, 1901. Paper read before the 73rd Naturforscherversammlung at Hamburg, 1901.)—The paper contains a comparison of a Schubert psychrometer with an aspiration-psychrometer, gives a formula for absolute humidity, and describes a self-registering wet and dry bulb hygrometer. Both instruments are made by R. Fuess, of Steglitz, near Berlin. H. B.

653. *Applications of Elastic Solids to Metrology.* **C. Chree.** (Phil. Mag. 2. pp. 532–558, Nov., and pp. 594–616, Dec., 1901. Paper read before the Physical Society of London, May 10, 1901.)—An elaborate mathematical and critical paper to which it is hard to do justice in a short abstract. The chief subjects treated are as follows: Effects on solids of suspension and supports, pressure of surrounding medium, æolotropic solids, cylinder suspended from the rim, solid prism with axis vertical, flask containing liquid, hollow bodies containing or surrounded by liquid, standards of length, numerical applications to standards of length and to deflection bars of magnetometers. E. H. B.

654. *Motion of Water through Sand.* **P. Forchheimer.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 1736–1741, Dec. 7; and pp. 1781–1788, Dec. 14, 1901.)—This paper treats very fully the rate of flow of water through sand and various filtering media, and gives numerous references to the literature of the subject. W. W. H. G.

655. *Work of Paris Observatory.* **M. Lœwy.** (Revue Scientif. 16. pp. 588–593, Nov. 9, 1901.)—This is the annual report of the director, and gives a *résumé* of the observations made during the past year. C. P. B.

656. *Apparatus for Measuring Variations of Small Zenithal Distances.* **G. Lippmann.** (Comptes Rendus, 134. pp. 205–208, Jan. 27, 1902.) A. D.

657. *Determination of the Apex of the Sun's Way.* **J. C. Kapteyn.** (Archives Néerlandaises, 6. pp. 262–284, 1901.)—A consideration of the conditions necessary for determining the direction of movement of the solar system in space, by reduction of the parallactic displacements of stars in various parts of the sphere, taking into account the possible proper motions affecting the stars used for the investigation. C. P. B.

LIGHT.

658. *Range-finders.* **G. Forbes.** (Soc. Arts, Journ. 50. pp. 78-86, Dec. 20, 1901.)—A portable instrument is described and explained, suitable for use by infantry. Stereoscopic vision is employed to get over the difficulty of "spotting" the object. The aluminium base contains four pentagonal prisms, and the rays entering each end of the base pass through two of these prisms, being twice internally reflected in each before reaching the Zeiss binocular. The base is 6 feet long, and has a hinge in the middle, by means of which the instrument can be folded up, or used with one half of the base acting as a support. The base weighs 2½–3 lbs. and the binocular 2½ lbs. When the latter has a magnifying power of 12 the author claims an accuracy of about ½ per cent. at 3,000 yards. In the eyepieces there are vertical marks, one fixed and the other movable by a micrometer screw, the reading of which gives the distance required when the two marks coincide. G. E. A.

659. *Stereoscopic Apparatus.* **E. Berger.** (Zeitschr. Instrumentenk., Beib. 21. pp. 201–203, Nov. 1, 1901.)—This instrument, called by the author a Platoscope, consists in the main of a pair of de-centred convex lenses set at an angle to one another and placed close behind a pair of de-centred concave lenses, which are somewhat less inclined to one another. The focus of the central portions of the systems lies at a certain distance behind the focus of the peripheral portions. If the picture to be observed be placed just inside the central focus, only the middle portion will be seen. If the picture be now brought nearer to the lenses until just inside the peripheral focus, the whole will, after a short observation, appear in perfect relief. The author further recommends the use of this instrument as a form of optometer for testing the eyesight. E. C. C. B.

660. *Periscopic Lenses.* **A. S. Percival.** (British Optical Journ. 1. pp. 54–56, Nov., 1901. Paper read before the British Medical Association.)—Periscopic spectacle lenses are intended to enable the wearer to see objects on either side of him distinctly by moving the eyes only, without moving the head. The author states that the glasses commonly sold as periscopic are hardly worthy of the name, but that he has solved the problem satisfactorily for powers up to +or —10 diopters. The surface next the eye must always be concave, but this causes no appreciable aberration, as the pupil makes the cone incident on the retina of very small dimensions. The outer surface is convex for powers from +20D to —8D, and generally concave for higher myopic powers. Both surfaces are spherical, except in cases of compound astigmatism, when the outer surface must be toric. An optician's estimate is quoted, that periscopic spherical lenses would cost half as much again as ordinary lenses, and periscopic toric lenses not more than twice as much as ordinary sphero-cylinders. A table of radii of curvature is given. The radius of the surface next the eye is made a maximum, viz., 108 mm., for power +5D; its value for —20D is 32 mm., and for +20D, 50 mm. The mathematical calculations are not given, but will be published in Knapp's Archives. A. E.

661. *Instruments for Measuring Distance between the Eyes.* **E. Dönitz.** (Zeitschr. Instrumentenk. 21. pp. 260–265, Sept., 1901.)—The author discusses the theory of the subject in general, and describes in particular two little instruments recently brought out by Zeiss. The first, and simpler one, intended for self-measurement, is a small flat box to be held horizontally in front of the eyes. Within are a scale and a strip of mirror facing each other. The observer, holding the scale under his eyes, looks over it into the mirror, and fixes each pupil in turn upon its own reflection. For the convenience of those who cannot shut one eye, the central part of the mirror is covered so that neither eye can see the image of the other. The left pupil is placed at the zero of the scale, and it is only necessary to note the reading for the right pupil, which gives at once the distance between the pupils. The second apparatus is chiefly intended for the use of oculists, though it can be employed for self-measurement. It is supported on two connected parallel bars, held by the operator so that a cross-piece at one end is pressed against the patient's brows. The patient looks into a mirror, and by means of a second mirror, the operator sees the pupils projected on the image of a divided scale.

Pulfrich has suggested a method of self-measurement, with a scale and mirror, by holding the scale as far behind the mirror as the eye is in front of it. The scale and vertical image are then at the same distance from the eye, so that the usual trouble from stereoscopic parallax is avoided. The interval between the pupils for converging vision on a point at 250 mm. distance is nearly 4 mm. less than for parallel vision (for eyes 65 mm. apart). With application to spectacles for reading, the author suggests that as the interval for parallel vision is the simplest to measure, it may be best to obtain the interval for converging vision from it by means of tables. A. E.

662. *Aron's Mercury Lamp for Colour Experiments.* **E. Merritt.** (Amer. Phys. Soc., Bull. 2. pp. 30–31, 1901.)—The light from this lamp, being chiefly due to three lines in the violet, green, and yellow, can be utilised for illustrative experiments on colour. For instance, deep red autumn leaves illuminated by the above lamp appear black, but yellow leaves appear deep green, *i.e.*, their actual colour is due to a mixture of green and red. G. E. A.

663. *Focussing a Collimator by Parallax.* **G. Lippmann.** (Comptes Rendus, 134. pp. 16–17, Jan. 6, 1902.)—A point of the image, P say, is viewed through a lens. The lens is then displaced transversely to the line of vision by a distance of (in the case cited) 5 cm. If the collimator is in proper adjustment, P should be at infinity, and therefore the displacement should produce no effect. If, on the other hand, there is parallax, the movement will detect the fact. The accuracy of the method depends on the power of the lens. J. W. P.

664. *Pressure of Light.* **E. F. Nichols** and **G. F. Hull.** (Amer. Phys. Soc., Bull. 2. pp. 25–27, 1901.)—This paper contains a preliminary communication of a measurement of the normal pressure of light waves. The method consists, like Lebedew's, in measuring the angle of torsion of a vane exposed to the light, but the energy of the incident light is measured by a bolometer. The value found was about 80 per cent. of the theoretical value. [See also Abstract No. 1059 (1901).] G. E. A.

665. *An Acetylene Standard of Light.* **C. H. Sharp.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 927–930, Dec., 1901.)—A long series of experiments have been made in the hope of producing a standard of light with a constant flame of a pure gas in a pure atmosphere. A mixture of equal parts of acetylene and hydrogen in an atmosphere of oxygen gave, with the special burner, a flame of great brilliancy and steadiness, but it was found that its intensity was not reproducible from pressure measurements made on the gases. This was found to be due to the unequal solubility of the gases, which were stored over water. The reason for adopting the acetylene-hydrogen mixture was that, with the burner employed, pure acetylene deposited graphitic carbon about the jet with such rapidity as to quickly obstruct the flow of gas. This was not the case with the diluted gas. A new burner was at last found which would admit the use of pure acetylene. In this the acetylene passes through a tube which is surrounded by a water jacket, whilst the oxygen enters a concentric tube outside the water jacket, and issues through the nozzle in a stream surrounding that of the acetylene. With this arrangement there is no troublesome deposit of carbon. The flame so produced is the most brilliant gas-flame known. Its colour admirably adapts it for use as a secondary standard in arc-light photometry. The necessary details of construction and use to convert it into a definite standard have yet to be fixed. W. W. H. G.

666. *The Question of a Standard of Light.* **C. H. Sharp.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 931–934, Dec., 1901.)—It is pointed out that practice is settling down to the use of either a pentane or a Hefner amyl acetate standard for photometric purposes. For gas measurements the former is most favoured, and the latter for electrical work. The careful study of the Hefner lamp in the Reichsanstalt, the adoption of it officially in Germany, the resolution in its favour by the American Institute of Electrical Engineers, and by the Geneva Congress of 1896, have done much to popularise this standard. Nevertheless it would be better to have a standard considerably whiter. Among the ordinary sources of light the acetylene flame probably approaches most nearly in colour to the average light. The propositions of Violle, Fessenden, and Féry to adopt such a standard are mentioned, but no practical definite standard has been the outcome.

W. W. H. G.

667. *Theory of Vision.* **G. Bohn.** (Comptes Rendus, 134. pp. 184–186, Jan. 20, 1902.)—The author controverts Pizon's theory [see Abstract No. 289 (1902)], and upholds a chemical as against a mechanical theory. A. D.

668. *Spherical Aberration of the Eye.* **G. Weiss.** (Comptes Rendus, 134. pp. 98–100, Jan. 13, 1902.)—If a pin-hole is pierced in a card, and a uniformly and well-illuminated surface viewed through it, a luminous spot is seen with a faint but distinct circular shadow in the middle. By diminishing the size of the hole the zone of shadow is made greater in the same proportion. Measurements of an approximate kind are given, and explanation is found in the spherical aberration of the eye, a subject which the author states has received little attention. By contracting the pupil of the eye, or by using a diaphragm so as to cut off marginal rays, the phenomenon can be made to disappear. On dilating the pupil by the use of cocaine, the diameter of the shadow increases. In certain rare cases where the eyes are aplanatic the phenomenon will not occur. J. W. P.

669. *Temperature Regulation of the Stellar Spectrograph, Potsdam III.* **J. Hartmann.** (Zeitschr. Instrumentenk. 21. pp. 313–325, Nov. 1901.)—The error introduced by temperature change into the measurements of the wavelengths of spectrum lines may arise from two sources—first, the change of the refractive index of the material of the prism, and secondly, the expansion or contraction of the metal parts of the spectroscope. It is often very considerable, amounting to, for the spectrograph in question, from 0·212 to 0·222 tenth metres between $\lambda = 4{,}100$ and $\lambda = 4{,}500$ for a change of temperature of 1° C. This change corresponds to a difference of 14·8 to 15·5 kilometres per second in the apparent velocity of a star. Tables are given in the paper showing the rate of cooling and warming of the instrument as determined by measurements made of the iron spectrum. The author has designed a thermostat which keeps the temperature, by an electric regulator, quite constant during long exposures. It consists of a wooden box which entirely encloses the spectrograph when mounted on the telescope. On the two sides of the box directly facing the top and bottom of the prism chamber are two electric heaters in the shape of wire grids, which draw current from the observatory mains at 110 volts. On the top and bottom respectively of the prism chamber is a mercury contact thermometer with adjustable contacts. By means of these two thermometers the flow of small currents from Leclanché cells is governed, which, by means of two separate relay apparatus, control the main current through the heaters. In this way the two heaters are quite independently controlled, each one being provided with its own relay apparatus and thermometer. The maximum supply of electricity to the heaters can be varied by means of incandescent lamps in parallel. A trial of the apparatus gave most satisfactory results, inasmuch as the temperature was kept constant within a tenth of degree for twelve hours though the observatory temperature fell 7°. E. C. C. B.

670. *Visible Radiation from Carbon.* **E. L. Nichols.** (Phys. Rev. 13. pp. 65–80, Aug., and pp. 129–144, Sept., 1901. Paper read before the American Association for the Advancement of Science, N.Y., June 27, 1900.) —The visible radiation from carbon rods in vacuo, rendered incandescent by an electric current, is here compared by means of a spectrophotometer with the radiation from an acetylene flame. Since the radiation in both cases is from incandescent carbon, it was anticipated that a similarity would be found to exist between the spectra of the rods and that of the flame, especially when the rods were heated to very high temperatures. Great experimental difficulties were encountered in trying to measure the temperature of the rods by means of a thermoelectric junction, but these were finally overcome for all temperatures under 1,400°; above that temperature the carbon seems to combine with the metals of the junction, altering their properties. Temperatures above 1,400° were approximately determined by measuring the electric resistance of the rods, and extrapolating in the temperature resistance curve. The experimental results, when plotted, show that the above anticipation with regard to the similarity between the spectra is far from being realised, and that the distribution of energy in the spectrum of the carbon rod, instead of approaching that of the acetylene flame, as the temperature of the rod is increased, assumes an entirely unexpected character. Even at low temperatures, up to, say, 1,100°, the change in the spectrum is not of the simple character which was anticipated, and after passing 1,100°, a surprising complication arises in the results. The energy in the yellow of the spectrum, which from the beginning increases at a relatively more rapid rate than either the red or the blue, becomes so great as to give to the distribution curve a form entirely contrary to expectation. The isochroms for $0·7\mu$, $0·6\mu$, and $0·5\mu$, when plotted with logarithms of intensity as ordinates and absolute temperatures as abscissæ, are straight lines. J. B. H.

671. *Visible Radiation from Carbon.* **E. Blaker.** (Phys. Rev. 13. pp. 345–368, Dec., 1901.)—This investigation, which was carried out at Dr. Nichols' suggestion in Cornell University, repeats the experiments which Dr. Nichols made on the radiation from incandescent carbon rods [see preceding Abstract], with this difference—that ordinary incandescent lamp filaments were used instead of carbon rods. The temperature of the filament was obtained from a measurement of its resistance by means of le Chatelier's experimental researches on the connection between the temperature and resistance. The spectrophotometric comparison of the intensities of radiation from the lamp filament at different temperatures, with the corresponding radiations from a constant acetylene flame, confirm the general conclusions arrived at by Dr. Nichols—that the radiation from incandescent carbon in the form of rods is different from the radiation from carbon in an acetylene flame. A well-marked maximum of radiation is observed in the comparison curve at a wave-length about $0·62\mu$, and this maximum is much better marked in the highest temperature curves in the present paper than in those in Dr. Nichols' paper, owing to the higher temperatures to which the filaments could be heated. J. B. H.

672. *Visible Radiation from Carbon.* **E. L. Nichols** and **E. Blaker.** (Phys. Rev. 13. pp. 378–380, Dec., 1901.)—The existence of a selective radiation from glowing carbon found by the authors during their researches on the radiation from carbon rods [see the two preceding Abstracts] has been remarked upon by Brace as probably agreeing with the anomalous dispersion of carbon noted by previous investigators. The authors in the present paper compare the experimental results of previous investigators of the dispersion of carbon, and, as these results seem to vary considerably with the different carbons used, the authors are investigating the subject further. The absorption of a carbon deposit on an incandescent lamp bulb was found by Moore and Ling to be a maximum for the wave-length $0·635\mu$, which is very near the region of maximum radiation observed by the authors. J. B. H.

673. *Quantitative Spectra of Beryllium.* **W. N. Hartley.** (Roy. Soc., Proc. 69. pp. 283–285, Jan. 31, 1902.)—A tabular statement is given of the spectrographic results obtained with spark spectra of solutions of beryllium of different dilutions, varying from 1 per cent. to 0·000001 per cent. The sensitiveness of the reaction is almost without limit, as with the most dilute solutions the two lines at $\lambda = 3130·3$ and $\lambda = 2478·1$ were visible with a coil giving a 5-inch spark, and the effect is enormously magnified with a larger coil and condenser. It was found in testing analytical methods of separation of beryllium from aluminium that the alumina persistently showed traces of beryllia. E. C. C. B.

674. *Structure of Mercury Spectrum.* **O. Lummer** and **E. Gehrcke.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 2. pp. 11–17, Jan. 9, 1902.)—This is an analysis of the lines of the mercury spectrum made by interference methods of high resolving power, simply obtained by allowing the light from an electric arc in mercury vapour to fall obliquely upon a strip of plane parallel

glass plate. The rays enter the glass plate, and part of them by a series of reflections traverse the whole length of the plate, but at each point of reflection a certain portion passes into the air, and these refracted rays all pass into a telescope, where they can be observed. The method was more fully described in a previous publication. The spectrum lines of mercury are in this way resolved usually into a principal component with several subordinates; for example, the bright green line has ten such subordinates.

E. C. C. B.

675. *Determination of Absolute Wave-lengths in Spectra.* **C. Fabry** and **A. Pérot.** (Annal. Chim. Phys. 25. pp. 98–139, Jan., 1902.)—The paper describes a series of determinations of the absolute wave-lengths of certain lines by methods of interference. Exception is taken in the first place to the adoption of either of the D lines as a standard, on account of their variable size, and in the second to any solar lines, on account of the relative motions of the sun and the earth. The standard to which the published measurements are referred is the red cadmium line of Michelson and Benoît, $\lambda = 6438{\cdot}4722$ in air at 15° and 760 mm. pressure. The actual method employed was to directly compare the standard ray with the ray in question in an interference apparatus which was more fully described in a previous paper [see Abstract No. 1892 (1901)]. The ray actually used as standard of comparison was the principal component of the green cadmium ray. A series of wave-lengths as determined are given, and in the case of those dealing with the solar spectrum, the values of the ratio of Rowland's numbers to those found are given, and these lie between 1·0000286 and 1·0000381. [See also Abstract No. 2106 (1901).]

E. C. C. B.

676. *Ultraviolet Spark Spectrum of Holmium.* **F. Exner** and **E. Haschek.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 487–507, May and June, 1901.)—The spark spectrum of the element holmium between the limits of $\lambda = 4698$ and $\lambda = 2243$ containing 1,905 lines, the authors had no reason to doubt that their specimens, which were obtained from two different sources, were as pure as possible. In an addendum they modify a statement previously made as regards lines common to the spectra of Samarium and Gadolinium, and in the present paper publish a list of some 30 lines which are of equal but weak intensity in both the spectra. These lines probably belong to a third substance. [See also Abstract No. 1993 (1900).] E. C. C. B.

677. *The Arc Spectrum of Hydrogen.* **O. H. Basquin.** (Amer. Acad., Proc. 37. pp. 161–174, Sept., 1901.)—The paper describes a series of visual and photographic observations of the arc spectra of tin, silver, copper, magnesium, aluminium, zinc, and sodium. The spectra showed the hydrogen lines very diffused, especially towards the blue end of the spectrum. In the above series of metals the first gives the best hydrogen lines, and weakest metallic lines, and the last the weakest hydrogen and strongest metallic lines. Characteristic metallic flutings were, except in the case of tin, seen forming bands, which, with silver, aluminium, and copper, are degraded towards the red, and with the others towards the blue. The wave-lengths of these flutings are given, and the author suggests in explanation the existence of hydrogen-metallic compounds. [See Abstract No. 2101 (1901).]

[It is very interesting to note that the bands given in this paper are identical with the bands given by Hartley and Ramage in their paper on the flame spectra of metals. [See Abstract No. 295 (1902).] This would preclude the idea of hydrogen-metallic compounds, and also show that the arc in hydrogen and the flame of hydrogen in oxygen are very comparable as means of producing spectra. This is in agreement with Jackson's theory of phosphorescence.] [See Abstract No. 439 (1899).] E. C. C. B.

678. *Structure of the Cyanogen Bands.* **A. S. King.** (Astrophys. Journ. 14. pp. 323–330, Dec., 1901.)—On photographing the spectrum of the carbon arc in air with a long exposure, two new bands were found with heads at $\lambda = 3465{\cdot}69$ and $\lambda = 3203{\cdot}84$, which the author concludes belong to the same series as the cyanogen bands at $\lambda = 3590$ and $\lambda = 3883$. By surrounding the arc with carbon dioxide and oxygen the carbon bands are brightened, but when nitrogen is used the cyanogen bands are slightly strengthened. The author therefore tends to Smithell's view that the carbon bands are due to carbon dioxide. [Smithell's view is that carbon bands are due to carbon monoxide, not dioxide.] E. C. C. B.

679. *Radiochrometer for Röntgen Rays.* **L. Benoist.** (Comptes Rendus, 134, pp. 225–227, Jan. 27, 1902.)—The author proposes to use the results he has already established, concerning the transparency of various substances to Röntgen rays, as a means of giving an experimental definition of the quality of the radiation emitted by a Röntgen-ray tube. [See Abstract No. 1887 (1901).] The transparency of silver to the radiation, as he has already shown, does not alter much with the quality of the latter. On the other hand the amount transmitted by aluminium depends largely on the state of the tube, and hence on the quality of the rays. A disc of aluminium is formed, consisting of twelve sectors, whose thicknesses increase from 1 to 12 mm. The central part is cut away, and is replaced by silver 0·11 mm. thick. The whole is backed by a fluorescent screen. When Röntgen rays fall on it, it is at once seen which thickness of aluminium transmits the same amount as the central silver part. We thus get a scale of hardness of the rays, divided into twelve arbitrary parts. R. S. W.

680. *Röntgen Rays.* **W. Rollins.** (Elect. Rev. N.Y. 39. p. 794, Dec. 28, 1901.)—Röntgen rays, if sent through a condenser of 500 aluminium sheets, are not retarded as they should be if they consisted of flights of charged particles, nor are they deflected on rotating the condenser. For medical work with photographic plates reduce the kathodes, reduce the storage capacity of the secondary coil to a corresponding degree, and send the surges as fast and as regularly as possible; the exposure for a hand is then practically instantaneous. The kathode stream particles come from several sources, the terminals and the residual gases, and the gases must have free circulation so that the kathode stream may have time to recuperate. A. D.

681. *Primary and Secondary Röntgen Radiation.* **H. S. Allen.** (Phil. Mag. 3. pp. 126–128, Jan., 1902.)—The author compares the ionisation produced by the secondary rays with that which would be produced by the primary rays if they continued their path in the original medium, and hence, on the assumption that ionisation is proportional to energy of radiation, deduces the ratio of the energies in the two kinds of radiation. The ionisation produced by the secondary rays was determined by Perrin's method (Comptes Rendus, 124. p. 445) of comparing the rates of leak of two condensers caused by primary radiation alone and by primary and secondary combined. The absorption was determined by Rutherford's method (Phil. Mag. 43. pp. 259–

265, 1897). As yet a complete determination has been made only in the case of sulphuretted hydrogen, which has a large absorption coefficient, with the result that the ratio of the total ionisation due to the secondary radiation from a brass plate, to the total ionisation for the primary radiation, is found to be approximately 1/1900; whence it follows that the total energy of the secondary radiation only amounts to about 1/2000 of that of the primary. G. W. DE T.

682. *Radio-activity.* **H. Becquerel.** (Comptes Rendus, 134. pp. 208–211, Jan. 27, 1902.)—Photographic plates show that the radiations from uranium are wholly deviable by a magnetic field (exposures up to forty-two days); from polonium wholly non-deviable; from radium, mixed. If there be traces of non-deviable radiation from uranium they would require enormous exposures; even with radium they are very penetrating and act very slowly. The deviable radiations from uranium correspond to the least deviable portions of the radiation from radium. In the transformation of white into red phosphorus by the radiations from radium the deviable radiations, identical with kathode rays, are active (sixty days' exposure through glass, which absorbs the non-deviable radiations, and thus leaves the question open whether the non-deviable rays would not also act in the same way); secondary radiations from lead are very active. A. D.

683. *Radio-active Substances.* **P. Curie** and **Mme. S. Curie.** (Comptes Rendus, 134. pp. 85–87, Jan. 13, 1902.)—The authors mention the ideas on the subject which have guided them in their researches. They look upon radio-activity as an *atomic* property of bodies. Each atom of a radio-active substance acts as a constant source of energy. Many varied consequences may be drawn from this hypothesis, which can be submitted to the test of experiment without knowledge of the source whence the radio-active body draws its energy. Experiment points to the conclusion that the radiant activity is rigorously the same whenever the radio-active body is brought back to the same chemical and physical state, and that this activity does not vary with time. Suppositions as to the origin of the energy of radio-activity group themselves round two very general hypotheses: (1) Each radio-active atom possesses in the condition of potential energy the energy which it sets in action; (2) the radio-active atom is a mechanism which draws at each instant from outside of itself the energy which it sends out. On the first hypothesis the potential energy should in the long run become exhausted, but the experience of years has hitherto not indicated any variation. It is conceivable that the radio-active atoms are in course of transformation, but experiment has yielded only negative results. On the second hypothesis radio-active bodies are transformers of energy. This energy might be taken, contrary to the principle of Carnot, from the heat of the surrounding medium, which would experience cooling. It might be furnished from unknown sources—for example, by radiations with which we are not acquainted. J. J. S.

684. *Negative Electrification of Secondary Rays.* **P. Curie** and **G. Sagnac.** (Journ. de Physique, 1. pp. 13–21, Jan., 1902.)—Secondary rays, from heavy metals struck by Röntgen rays, carry negative charges and leave positive charges on the metal; in a high vacuum these charges are independent of the distance traversed, but in presence of air-particles the charges dissociate the neutral electricity of the air into positive and negative particles, just as kathode rays and the deviable radiations from radium do. The exciting Röntgen rays act in producing kathode rays, just as ultra-violet light does

in producing a flux of negative electricity even from an uncharged metal (Righi, Lenard, Meritt, O. M. Stewart), through the production of particularly absorbable kathode rays, traceable only in a high vacuum. Röntgen rays, on the other hand, carry no charges; radium emits uncharged Röntgen rays and charged kathode rays mixed; and it is more and more probable that secondary rays really present a similar mixture. [See also Abstract No. 1644 (1901).] A. D.

685. *Deflection of Becquerel Rays and the Apparent Mass of the Electrons.* **W. Kaufmann.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 143–155, 1901.)—Following up the investigation referred to in Abstract No. 2111 (1901) the author concludes from his experiments that the ratio of the apparent to the real mass of the electrons is of the order one-third for velocities small compared with that of light. E. H. B.

REFERENCES.

686. *Testing of Children's Eyesight.* **J. H. Sutcliffe.** (British Optical Journ. 1. pp. 86–88, Dec., 1901; pp. 116–118, Jan.; and pp. 140–141, Feb., 1902. Paper read before the Manchester Optical Society, Nov. 20, 1901.)—Suggestions as to procedure in preliminary examination, on Burchardt "dot" system, where large numbers of children have to be tested and classified. A. D.

687. *Wave-Number System of Rhodium.* **C. P. Snyder.** (Astrophys. Journ. 14. pp. 179–180, Oct., 1901.)—The paper contains a table of wave-numbers of the arc spectrum of rhodium containing 476 out of a total of 1471. E. C. C. B.

688. *Colouring of Fluorspar by Kathode Rays.* **W. B. v. Czudnochowski.** (Phys. Zeitschr. 3. pp. 82–85, Dec. 1, 1901.)—The paper contains some further observations in continuation of a previous note. [See Abstract No. 383 (1901).] R. S. W.

689. *Duration of Röntgen Ray Emission.* **E. Colardeau.** (Soc. Franç. Phys., Séances, 2. pp. 113–117, 1901.)—The paper contains a fuller account of the experiments referred to in Abstract No. 1073 (1901).

HEAT.

690. *Determination of Vapour Pressure by Evaporation.* **W. Müller-Erzbach.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 519–536, May and June, 1901.)—The method was explained in Abstract No. 2425 (1900). It proves very convenient and reliable, provided the temperature be kept steady and be not near the boiling-point. According to Stefan, the diameters of the tubes from which the liquid is evaporated should not exceed the limits 0·6 to 6 mm. The author obtained good results with tubes up to 23 mm., but a beaker, 46 mm. in diameter, lost three times its calculated amount of water vapour. From comparative determinations of the amounts of water and chloroform, evaporated at the same temperature, satisfactory values for the vapour pressure of chloroform were also derived more easily than by the manometric method. But solid substances—methyl oxalate, naphthalene, and the carbon chloride C_2Cl_6—yielded less concordant results, because they give off vapours of less than normal pressure; this circumstance, however, affects manometric methods likewise. H. B.

691. *Graded Condensation in Benzine Vapour.* **C. Barus.** (Science, 15. pp. 175–178, Jan. 31, 1902.)—The author describes the results of experiments on condensation in benzine, which, contrary to his expectation, confirm the nuclear theory. By adiabatic cooling on partial exhaustion, cloudy condensation was as densely produced in benzine vapour as in water vapour with phosphorus and other nuclei, and when the receiver was illuminated with white light diverging from an external point, axial colours were obtained running into higher orders than with water vapour. No doubt, owing to the lower latent heat of benzine, the drops formed were regularly larger. In the absence of nucleation either no marked condensation occurred or rain like a fine mist fell. In other experiments nearly parallel light was used, the sun's image being the coronal centre, and again an incandescent mantle seen through a small hole in a metallic screen by an eye looking centrally through the receiver. The coronas were fleeting, with a tendency to depart from the normal annular character into sharply defined horizontal strata; the speed of descent of the coloured bands was noticeable, as was their rise upward, like fog from a lake, on exhaustion. Owing to its smaller latent heat of evaporation the benzine drops are larger, and therefore the subsidence of the *loaded* nuclei more rapid than for water. Regarding the loaded nuclei as mechanical particles, the largest will eventually be in the lowest strata, and on increasing exhaustion, condensation takes place first at the bottom, since the smallest nuclei correspond to greatest vapour pressure, or difficulty in condensation, and the largest nuclei, being first loaded with condensed liquid and parting with it last, have had the longest time to fall. Similar experiments with benzol lead to the additional result that nuclei are produced by the liquid itself *spontaneously* in the dark. W. E. T.

692. *Measurement of High-pressure Explosions.* **J. E. Petavel.** (Manchester Lit. and Phil. Soc., Mem. 46. 2. pp. 1–16, Feb. 10, 1902.)—An exceedingly dead-beat sensitive high-pressure gauge, the movements in which are arranged to extend over not more than about $\frac{1}{500}$ inch, but are capable of being

continuously recorded on a large scale by a reflexion method, is here described. It is being applied in the investigation of the variations of pressure that occur during and after explosions of gaseous mixtures, in illustration of which the pressure curves for the explosion of two mixtures of air and coal-gas are given and explained. They indicate that (1) the time required for the maximum pressure to be reached, viz., 0·058 sec., when the initial pressure is about 76 atmospheres, is much about what it is for the same mixture under 1 atmosphere; (2) the ratio of the maximum to the initial pressure increases with the latter, being about 8·5 for 76 atmospheres initially, and about 7 for 1 atmosphere; (3) the rate of cooling of the exploded mixture greatly decreases with increase of the pressure.

With these two mixtures the rate of rise of pressure is small for about 0·05 sec. and then becomes about nine times as great, such alteration of curvature not occurring with less explosive mixtures; the change seems to occur when the mixture is at a mean temperature about equal to that at which spontaneous ignition would take place. R. E. B.

693. *Cooling of Closed Rooms.* **G. Recknagel.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 1801–1809, Dec. 21, 1901.)—This is an application of Fourier's theory and method to a closed empty room with walls that are impervious to heat except on one side, where it is separated from the outer air, at constant temperature A, by a homogeneous and windowless wall, of surface F, thickness δ (small in comparison with F), density s, specific heat w, and conductivity λ, the enclosed air being perfectly still and at the same temperature J throughout.

If the temperatures throughout are stationary, those of the faces of the wall being $\mathfrak{T}_i$ and $\mathfrak{T}_a$, and h_1, h_2 are the external conductivities of the wall inwards and outwards (which may differ by reason of wind, &c.), the flow of heat is given by—

$$h_1(J - \mathfrak{T}_i) = \lambda(\mathfrak{T}_i - \mathfrak{T}_a)/\delta = h_2(\mathfrak{T}_a - A),$$

so that—

$$\mathfrak{T}_i - A = (J - A)(1 - p/h_1), \qquad \mathfrak{T}_a - A = (J - A)p/h_2,$$

where p is the *transmission-coefficient* of the wall which is given by—

$$1/p = 1/h_1 + \delta/\lambda + 1/h_2\,;$$

and the temperature U at any point in the wall distant x from the inner face is given by—

$$U - A = (J - A)(1 - p/h_1 - px/\lambda).$$

If the temperatures are variable, then—

$$\partial U/\partial z = \kappa\partial^2 U/\partial x^2,$$

where z denotes time and $\kappa \equiv \lambda/sw$: a simple integral is—

$$U - A = a(\cos mx + \beta \sin mx)e^{-\kappa m^2 z},$$

where a, β, m are constants. At the outer face we must have—

$$Fh_2(\mathfrak{T}_a - A) = -F\lambda[\partial U/\partial x]_{x=\delta} \text{ and } \mathfrak{T}_a = [U]_{x=\delta}$$

whence—

$$\tan m\delta = (\beta m + p_2)/(m - \beta p_2),$$

where $p_2 \equiv h_2/\lambda$, so that there is an infinite number of possible values of m, and thus, if $e_n \equiv exp(-\kappa m_n^2 z)$, the general solution is of the form—

$$\mathrm{U} - \mathrm{A} = \Sigma . a_n e_n (\cos m_n x + \beta_n \sin m_n x).$$

Also at the inner face we must have—

$$\mathrm{F}h_1(\mathrm{J} - \mathfrak{T}_i) = -\mathrm{F}\lambda[\partial \mathrm{U}/\partial x]_{x=0} \text{ and } \mathfrak{T}_i = [\mathrm{U}]_{x=0},$$

whence—

$$\mathrm{J} - \mathrm{A} = \Sigma . a_n e_n (1 - \beta_n m_n / p_1),$$

where $p_1 \equiv h_1/\lambda$. But if L is the mass of the inner air and c its specific heat, the flow of heat is also $-\mathrm{L}c\partial\mathrm{J}/\partial z$, or—

$$\partial \mathrm{J}/\partial z = (\mathrm{F}\lambda/\mathrm{L}c)\Sigma . a_n e_n \beta_n m_n ;$$

and $\mathrm{J} = \mathrm{A}$ when $z = \infty$, so that—

$$\mathrm{J} - \mathrm{A} = -\sigma \Sigma . a_n e_n \beta_n / m_n,$$

where $\sigma \equiv \mathrm{F}sw/\mathrm{L}c$. Thus—

$$1 - \beta_n m_n / p_1 = -\sigma\beta_n/m_n \quad \text{or} \quad \beta_n = p_1 m_n/(m_n^2 - \sigma p_1),$$

so that the equation giving the values of m is—

$$m \tan m\delta = \{(p_1 + p_2)m^2 - \sigma p_1 p_2\} / \{m^2 - p_1(\sigma + p_2)\}.$$

The values of the coefficients $a_1, \ldots$ are obtained from the initial conditions by a method analogous to that of Fourier. Initially we have—

$$\mathrm{U}_0 - \mathrm{A} = \Sigma . a_n (\cos m_n x + \beta_n \sin m_n x).$$

Now we easily prove that—

$$\int_0^\delta (\cos m_n x + \beta_n \sin m_n x)(\cos m_r x + \beta_r \sin m_r x) dx$$

$$= -\sigma\beta_n\beta_r/m_n m_r, \text{ if } n \text{ is unequal to } r, \text{ and}$$

$$= \sec^2\phi_r \{m_r\delta + \sin m_r\delta \cos(m_r\delta - 2\phi_r)\}/2m_r \equiv \mathrm{B}_r, \text{ if } n = r,$$

where $\phi \equiv \tan^{-1}\beta$. Thus—

$$\begin{aligned} \Phi_r &\equiv \int_0^\delta (\mathrm{U}_0 - \mathrm{A})(\cos m_r x + \beta_r \sin m_r x) dx \\ &= -\sigma(\beta_r/m_r)(\Sigma . a_n\beta_n/m_n - a_r\beta_r/m_r) + \mathrm{B}_r a_r \\ &= (\beta_r/m_r)(\mathrm{J}_0 - \mathrm{A} + \sigma a_r \beta_r/m_r) + \mathrm{B}_r a_r, \end{aligned}$$

where J_0 is the initial temperature of the enclosed air, so that—

$$a_r = \{\Phi_r - (\mathrm{J}_0 - \mathrm{A})\beta_r/m_r\} / \{\mathrm{B}_r + \sigma(\beta_r/m_r)^2\}.$$

The problem is thus completely solved. The loss of heat in time z is—

$$\begin{aligned} \mathrm{V}_z &\equiv \mathrm{F}h_2\int_0^z (\mathfrak{T}_a - \mathrm{A}) dz \\ &= (\mathrm{F}h_2/\kappa)\Sigma . (a_n/m_n^2)(\cos m_n\delta + \beta_n \sin m_n\delta)(1 - e_n), \end{aligned}$$

the constant part of which obviously denotes the excess of the heat in the wall and enclosed air initially over what they would have at A, and the remainder denotes the similar excess at the time z.

If the initial state is that of stationary temperatures, then—

$$U_0 - A = (J_0 - A)(1 - p/h_1 - px/\lambda),$$

so that—

$$\Phi_r = (J_0 - A)\left\{p/\lambda + (1 - p/h_1)\beta_r m_r\right\}/m_r^2,$$

and thus—

$$\Phi_r - (J_0 - A)\beta_r/m_r = -(\sigma p/\lambda)(J_0 - A)\beta_r/m_r^3.$$

Consequently $(U - A)/(J_0 - A)$ is independent of the absolute values of the temperatures.

This theory is applied to a room of volume 100 c.m., with a brick wall for which $F = 20$ sq.m., $\delta = \frac{1}{4}$ m., $s = 1800$, $w = 0{\cdot}2$, $\lambda = 0{\cdot}7$, $h_1 = h_2 = 6$ Cal. per hour (which assumes that there is no wind outside, otherwise h_2 might amount to 36), so that $p = 42/29$, $p_1 = p_2 = 60/7$, $\kappa = 1/514$. [The author takes $\sigma = 250$, and therefore apparently assumes for c the isopiestic value 0·2389 in place of the isometric one, since, for the dimensions taken, $L = 120{\cdot}5$ at 1 atmosphere and 20°.] Then—

$$\tan \tfrac{1}{4}m = 120(7m^2 - 7500)/(49m^2 - 108600)$$

$$\beta = 60m/(7m^2 - 15000),$$

which give the following values in order :—

Order.	m	$m\delta$	β	ϕ	$e^{-\kappa m^2}$	$a/(J_0 - A)$
1	4·338	62° 9′	−0·01751	− 1° 0′	0·9640	0·63894
2	14·45	180° + 27 0	−0·06407	− 3 40	0·6661	0·07651
3	25·82	360 + 9 50	−0·1499	− 8 32	0·2735	0·03235
4	37·04	540 − 9 20	−0·4120	− 22 23	0·0694	0·02395
5	45·48	720 − 68 32	−5·243	− 79 12	0·0179	0·00407
6	58·24	720 + 42 34	0·6636	33 34	0·00404	−0·01000
7	64·42	900 + 22 48	0·2751	15 23	0·000241	−0·00374

The values of a in the last column are calculated on the assumption of the temperatures being initially stationary. If $J_0 = 20°$ and $A = -20°$, the following distributions of temperature occur at the times specified :—

Time in hours.	0	1	2	10
Enclosed air	20	7·82	5·6	− 2·1
Inner face of wall ...	10·35	7·10	5·2	− 2·2
At 0·2 of its thickness	6·2	5·4	4·1	− 2·7
„ 0·4 „ „ ...	2·1	1·9	0·9	− 4·0
„ 0·7 „ „ ...	− 4·1	− 4·1	− 4·2	− 7·4
Outer face of wall ...	− 10·35	− 10·35	− 10·53	− 12·24
Outer air	− 20	− 20	− 20	− 20

These show the slow cooling of the outer face of the wall and the initially very rapid cooling of the enclosed air in comparison with that of the inner face of the wall.

If the maximum amount of heat which the enclosed air can lose, viz., $Lc(J_0 - A)$, is taken as unit, the total amount there is initially to lose is

0·01502σp_s = 32·19, of which the air possesses 1 and the wall 31·19; after 10 hours the amount there is to lose is 0·01061σp_s = 22·74, of which the air has 17·9/40 = 0·45 and the wall 22·29. Thus in 10 hours the loss is 9·45/32·19 = 0·294 of the whole, and of this loss the air has supplied only about one-seventeenth. Further, during this period the average rate of loss is 0·945 per hour, which is but little less than at the start, viz., 1·006. R. E. B.

694. *Heat of Inversion of Saccharose.* **P. Petit.** (Comptes Rendus, 134. pp. 111–112, Jan. 13, 1902.)—The author gives results of measurements of the heat evolution taking place when saccharose undergoes inversion. The experiments were made by means of a closed calorimeter surrounded by a double envelope of vapour from a constant boiling-point liquid. The mean values obtained for the heat evolved when 1 grm.-mol. of saccharose, dissolved in 140 grm.-mols. of water, is inverted are: (1) 2·639 cals. at 53·5° and (2) 2·675 cals. at 63°. T. H. P.

695. *Man as a Heat-Engine.* **K. Schreber.** (Phys. Zeitschr. 3. pp. 107–109, Dec. 15, 1901.)—If we take the interior temperature at 37° and the exterior as 17° (the average temperature of the air), we find the efficiency would be 100 × (37 − 17) ÷ (37 + 273) = 6·5 per cent. Rühlmann gives an estimate up to 24 per cent., but this is vitiated by irregularities of effort which may mount as high as 1 h.p., though the average over a long period is less than 0·1 h.p., and these irregularities do not at once call for similar variations in food. Observations must therefore extend over considerable periods. Ržiha gives the datum 127,000 kg.m. as a man's mean daily work over such a period. Grasmann gives the heating value of a man's food, per 100 kg. body weight, as 3,400 Ca during rest, 5,400 during moderate, and 7,600 during hard work. For a man of 60 kg. weight these data would give 6·5 per cent. efficiency during hard work. But 60 kg. is too little; say 70 kg.; then the efficiency is 5·6 per cent. Ržiha's hardest day's work was 141,000 kg.m. Taking this datum we have for a man 60 kg. weight an efficiency of 6·2 per cent. If instead of 37°, as above, we take 39°, the temperature of the blood, the 6·5 per cent. above is increased to 7·1 per cent. The estimation of the inferior temperature is, however, of more importance, but is difficult; if we take the temperature of the skin (32°·3 to 35°·8 and 31° on the face), our theoretical efficiency would be only 2·6 per cent. The work of the involuntary muscles may be neglected (the heart 3,000 m.kg. a day). With a theoretical efficiency of only 2·6 per cent., man as a heat-engine would not obey Carnot's law. He should probably be likened not to a heat-engine, but to an electric station with a large accumulator capacity; but it would be difficult, for any short-period test, to ascertain what the reserve of energy was at the beginning and at the end of the test. Still some attempt should be made in that direction. A. D.

696. *Theory of Saturation State.* **C. Dieterici.** (Ann. d. Physik, 6. 4. pp. 861–869, Dec., 1901.)—A deduction is given of the equations—

$$\lambda = T(v_s - v_{l_s})dp_s/dT \text{ and } \lambda/T - d\lambda/dT = c_s - h_s$$

where λ is the latent heat of evaporation, p_s the saturation pressure, c_s and h_s the specific heats of the liquid and its vapour, which depends on the possibility of bringing a liquid under saturation pressure at a given temperature to the vapour state at the same pressure and temperature by two different paths—

(1) isothermally, whilst the pressure remains constant, (2) along the saturation curve, raising the temperature to the critical point and then cooling again to the given temperature. Also, from the consideration of the theoretical path suggested by van der Waals, which is both isothermal and continuous, the author deduces the equation $\int_{v_1}^{v_2}(\partial p/\partial T)dv = (v_2 - v_1)dp_s/dT$. Calculating, for various substances, the temperature for which the external work done in isothermal evaporation is a maximum, he finds that the critical temperature bears to it the constant ratio 1·30 to 1. W. E. T.

697. *Law of Constancy of Quantity of Heat.* **J. P. Kuenen.** (Archives Néerlandaises, 6. pp. 39–46, 1901.)—The conception, quantity of heat, was originally based on the results of the law of mixing, which may in the simplest case be expressed by the equation $\Sigma mc(t - T) = 0$, where m is the mass, c the specific heat, and t the temperature of any constituent of the *mixture*, T being the common final temperature. When change of state occurs the theory may be represented by the equation $\Sigma mc(t - T) + \Sigma Ml = 0$, where M is the mass of any constituent transformed, and l the latent heat, so called to indicate its independence of temperature. These equations do not strictly express the case, since specific heat varies with the temperature. The questions which present themselves are therefore: (1) What is the proper relation between the masses and temperatures? (2) Can this relation be interpreted so as to express the constancy of a quantity which can be defined as quantity of heat? (3) On what experimental facts is this relation based? The following experimental laws, if fully substantiated, would suffice for the determination of (1): (*a*) The final temperature of mixture, where no transformation of energy occurs, is independent of the order of mixture, and may be expressed in the form $T = F(m_1 m_2, \ldots t_1, t_2 \ldots)$; (*b*) If the masses are altered in the same proportion, the temperatures being the same, T will be unaltered: hence $T = \text{Hom}^{\circ}.(m_1, m_2, \ldots t_1, t_2, \ldots)$, which may be transformed into $\text{Hom}^{n}.(m_1, m_2, \ldots t_1, t_2 \ldots T) = 0$. Now take substances 1, 2, 3, 4, choosing values of m and t such that the mixtures 1,2; 2,3; 1,4, may have the same final temperature. Then the mixture 3,4 should have the same final temperature, or its characteristic equation should be the consequence of that for the other three mixtures. The third law (*c*) may therefore be stated thus: If of four substances of given mass and temperature 1 and 3 produce the same change in 2, while 2 and 4 produce the same change in 1, then 2 and 4 produce the same change in 3. These laws enable the character of the function to be determined, and lead to the equation $\Sigma_k m_k f_k(t_k - T) = 0$, as the expression for the law of mixture. Equation (3,4,) will then follow from the other three, viz.: $(1,4,) - (1,2,) + (2,3,) \equiv (3,4,)$. The conception of quantity of heat may then be introduced by defining $f_k(t_k - T)$ as the quantity of heat given off by unit mass of the substance in cooling from t_k to T, and the typical equation obtained expresses the law that in mixing bodies of different temperatures the total quantity of heat remains constant, which thus appears to be quite independent of the approximate laws of mixing, on which it was originally based, but is by no means a self-evident law. Whether it is correct can only be settled by experiments, and those suggested above appear to the author to be the simplest for the purpose, although others might serve equally well. G. W. de T.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

698. *Ether, Matter, and Electricity.* **N. E. Gilbert.** (Terrestrial Magnetism, 6. pp. 147–166, Dec., 1901.)—This paper is based on H. A. Rowland's ideas. The existence of permanent magnetism shows that any retardation of rotary or vortical motion, such as is held to explain magnetism, due to any kind of resistance, must be very slight. In the case of an electromagnet, any energy used in overcoming such resistance, if it exists, must be derived from the exciting current, and must manifest itself through an apparently greater resistance of coiled wire when a magnetic field is being maintained than when it is not; but the measurements show a resistance slightly *smaller* (by 1 in 1,200,000) in the former case. This tends to show that there is no drag between ether and matter: if there were, there ought to be a current generated in a wire wound on the periphery of a wheel in such a way that it would move in the direction of its length when the wheel was rotated, and further, this current would completely explain the earth's magnetism; but the result of an elaborate research is on the whole purely negative, no such current being found or, if any, not determinate in direction, and far too small to correspond with theory. A. D.

699. *Electric Field of an Ellipsoidal Conductor.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 449–453, May and June, 1901.)—Let the ellipsoid be represented by—

$$\frac{x^2}{a_0^2}+\frac{y^2}{b_0^2}+\frac{z^2}{c_0^2}=1 \quad\text{..........................(1)}$$

Then it is shown that the equipotential surfaces are the confocal ellipsoids—

$$\frac{x^2}{a_0^2+\lambda}+\frac{y^2}{b_0^2+\lambda}+\frac{z^2}{c_0^2+\lambda}=1 \quad\text{..................(2)}$$

The potential of any point is expressed in terms of the parameter λ of the surface on which it lies, and the charge Q on the conductor, by the equation—

$$V_\lambda=\frac{Q}{2}\int_\lambda^\infty \frac{d\lambda}{\sqrt{(a_0^2+\lambda)(b_0^2+\lambda)(c_0^2+\lambda)}} \quad\text{..............(3)}$$

E. H. B.

700. *Electrostriction.* **J. S. Shearer.** (Amer. Phys. Soc., Bull. 2. pp. 27–28, 1901.)—In order to test whether the electric field causes volume changes, a refractometer method was used on, among other things, long thin glass tubes silvered outside and in. The potential was gradually raised until the tube punctured, the tubes being 0·8 to 2·0 mm. thick. No movement exceeding $\frac{1}{8}$ of a band width was ever observed, and the author concludes that if electrostriction actually exists, its magnitude is much less than has been generally supposed. [See also Abstract No. 2440 (1900).] G. E. A.

701. *Daily Periodic Variation in Atmospheric Electricity.* **F. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 871–886, April, 1901.)—The measurements made at different places on the earth's surface show sometimes a single period and sometimes a double period in the day in the changes of atmospheric potential, while others again show a practically constant potential during the twenty-four hours. The single period has a flat maximum covering all the hours of the day, with a correspondingly flat minimum for the night. The double period has maxima about 8 a.m. and 8 p.m., separated by a strong depression of potential about midday. In some places the type changes with the time of year, giving the first type in winter and the second in summer. The author compares the measurements for many widely separated places, and concludes that the normal variation of atmospheric potential is given by a single period, and that the double period, which occasionally occurs, arises from a disturbance of the normal single period, resulting in a midday lowering of potential. This depression occurs especially in dry districts (or in summer), and appears to be the result of a negatively charged layer gathering at noon over the places of observation. This layer, which does not appear to extend beyond some hundred metres in height, also manifests itself by a strong absorption of the ultra-violet solar rays.
W. C. H.

DISCHARGE AND OSCILLATIONS.

702. *Dispersion of Electricity in Air.* **W. Loevy.** (Phys. Zeitschr. 3. pp. 106–107, Dec. 15, 1901.)—Strong wind favours dispersion of charge; so do rise of temperature, of moisture, and of atmospheric pressure. The coefficient of dispersion falls off when the voltage rises to, say, 500; and it is at a maximum at 8 a.m. and 8 p.m. Sunlight accelerates the dispersion of negative electricity; and during rain a unipolar dispersion of positive charge was found.
A. D.

703. *Ionisation of Air.* **H. Ebert.** (Phys. Zeitschr. 2. pp. 662–664, Aug. 17, 1901.)—Some account of this investigation has already been given in Abstract No. 2146 (1901) [see also Abstracts Nos. 629, 849, and 2144 (1901)]. The ionisation is great in sunny weather; when dust or smoke are present, or the relative humidity is high, it becomes less. Hence these cannot account for the loss of charge of an insulated body exposed to the air. Its absolute amount is small, on the average as much as would be produced by the ionisation of $\frac{1}{3} \times 10^{-14}$ grm. or $\frac{1}{3} \times 10^{-10}$ c.c. of hydrogen per c.m. If the 1–10,000 billionth part of the oxygen contained with air were dissociated, the ionic charges of this fraction would suffice to account for the effects observed.
D. E. J.

704. *Discharge from a Tesla Pole.* **E. Knoblauch.** (Ann. d. Physik, 6. 2. pp. 353–372, Oct., 1901.)—High-frequency currents discharged from a fine point in air impart a positive charge to an insulated metallic plate near at hand, whereas at greater distances the plate becomes negatively charged [see Abstract No. 844 (1901)]. According to Himstedt [Ann. d. Physik, 52. p. 473, 1894; and Abstract No. 1708 (1899)], both negative and positive electricity are discharged from a Tesla pole, but the negative electricity is propagated more rapidly than the positive; at short distances the positive electricity is in excess, whereas at great distances the negative alone reaches the plate. The author has measured the potentials of the plate and point

(Tesla pole) at various distances from each other, and has examined the circumstances under which the change of sign takes place. This change can easily be demonstrated by an electrometer, or even by a Bohnenberger electroscope. The discharge is started at a distance of about 6 cm. and the point gradually brought nearer to the plate; at 4–5 cm. distance the needle is violently disturbed and then goes over to the positive side. With plates 1 to 18 cm. in diameter this was found to occur at distances greater than 4–4·2 cm. The point of inversion can, however, be removed further by using a zinc plate of 18 cm. diameter with a circular opening of 2–8 cm. cut out of it: for the negative discharge appears to surround the positive charge like a mantle. If the opening is greater than 8 cm. diameter no positive charge can be given to the plate. The behaviour of the discharge can also be studied by means of Lichtenberg figures, which clearly show a negative ring surrounding a positive disc. These statements, however, only apply when the discharge is of the nature of a radiation from the point; the direct spark-discharge between point and plate is an oscillating discharge. D. E. J.

705. *Counter E.M.F. of the Arc.* **H. J. Hotchkiss.** (Amer. Phys. Soc., Bull. 2. pp. 19–22, 1901.)—The author's experiments lead to the conclusions, (1) that if there is a back e.m.f. dying out in one ten-thousandth of a second, it does not have an average value for that time as large as two-thirds of a volt; (2) at the instant the impressed e.m.f. is removed the back e.m.f. is probably very nearly zero, and increasing instead of decreasing; (3) after the first ten-thousandth of a second there is a back e.m.f. which rises rapidly at first, then more slowly, to a maximum of less than 1 volt in about one-fiftieth of a second. W. C. H.

706. *Deflection of the Magnetic Needle Produced by Kathode Rays.* **J. v. Geitler.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 358–364, April, 1901. From the Physik. Inst. der K.K. deutschen Universität Prag.)—From experiments described in Wiedemann's Annalen, 19, p. 798, and in his collected works, vol. i., Hertz was led to conclude that the kathode rays have no effect on a magnetic needle. In view of the fact that the rays are affected by a magnetic field, the author was led to seek for a possible source of error in Hertz's experiments. He supposes that the charges produced where the kathode rays meet the inner surface of the tube create a backward flow of tubular form, which backward current neutralises the effect of the rays on a needle situated outside of the backward tubular flow. He describes experiments to test this view, in which the magnetic needle is placed *inside* of the vacuum tube in which the rays are produced, in such a position that the backward tubular current surrounds the needle, and is therefore without effect upon it. He finds that the kathode rays affect the needle in the same way as a positive current flowing in the path of the rays but in the opposite direction. The results are qualitative only. W. S.

707. *Visible and Invisible Kathode Rays.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 3. 15. pp. 192–203, 1901.)—Various observers have found that if a plate kathode be used, which reaches to the walls of the tube, then, as the pressure is lowered, the luminous part of the kathode bundle of rays retreats to the centre of the disc. The author shows that this is due to the walls of the tube near the kathode acting as an anode, and that in this state there is a stream of invisible kathode rays proceeding from the outer portions of the

disc. They can be detected by the phosphorescence of the glass; this test shows that their paths are always more divergent than those of the visible rays. Other striking experiments are adduced to show their presence. It is found that any solid, neutral body becomes an anode if placed in the Crookes dark space; just beyond it is neutral, still further away it may act as a weak kathode. It is shown that these invisible rays differ from those visible, in their power of exciting phosphorescence, in their absorption by a gas, and in their erosive powers on the material of the kathode. R. S. W.

708. *Potential Difference and Damping of Oscillatory Sparks.* **F. Beaulard.** (Comptes Rendus, 134. pp. 90–92, Jan. 13, 1902.)—Correction is made of the numbers found for the difference of potential relative to a certain explosive distance which were given ten times too high in a previous paper. [See Abstract No. 2370 (1901).] J. J. S.

709. *Experiments with the Blondlot Oscillator.* **W. G. Hormell.** (Amer. Journ. Sci. 12. pp. 433–446, Dec., 1901.)—This paper describes experiments in which, by means of a modified form of Blondlot oscillator, the dielectric constant of paraffin wax was determined for wave-lengths of 40, 60, and 80 cm. respectively. It also describes an investigation of the relative velocities of waves of 80 cm. along wires of different diameters, some of the wires being of magnetic and some of non-magnetic material. The following conclusions are arrived at. For reversals as high as 800 millions per second the velocity of electrical disturbances along magnetic and non-magnetic wires of different diameters is the same, thus indicating that magnetic variations are not able to follow such rapid changes of magnetising force. The effective field around the Lecher wires, so far as it can be detected by means of an argon tube, does not extend more than 3 cm. from the wires; and the effect on the half-wave within this region varies, approximately, inversely as the square of the distance from the wires. The dielectric constant of a given paraffin wax increases with the density. From a temperature 20° C. above the melting-point to a temperature 30° below the melting-point it increases rapidly. Among different paraffins the dielectric constant increases as the melting-point increases. The dielectric constant increases as the wave-length decreases. It is greater for short light waves than it is for short electrical waves. Cauchy's formula as a means of obtaining the refractive index for indefinitely long waves does not agree with the results of experiment. R. A.

710. *Loaded Conductors.* **F. Breisig.** (Elektrotechn. Zeitschr. 22. pp. 1029–1030, Dec. 12, 1901.)—In developing his method for improving telephony over long lines, by proportioning the self-induction to the capacity and periodicity, Pupin arrived at the equation—

$$\beta^2 = \frac{mc}{2}\left(\sqrt{w^2 - m^2l^2} - ml\right),$$

where β is the damping constant, l the self-induction, c the capacity, m the number of alternations in 2π seconds, and w the resistance. Breisig points out that Pupin has omitted to include a factor for the leakage from the line; this factor a is the reciprocal of the resistance of the dielectric. Making use of this factor, and assigning known values to a, Pupin's results are revised, and expressions are found for the best conditions of working. R. A.

711. *Action of High-Frequency Currents on Animals.* **H. Bordier** and **Lecomte.** (Comptes Rendus, 133. pp. 1295–1297, Dec. 30, 1901.)—After referring to d'Arsonval's experiments, in which high-frequency currents of powers up to 720 watts produced no sensation in human beings, the authors go on to describe experiments of the same kind upon rabbits, rats, and other small animals. The experiments prove that such currents do, in animal tissues, penetrate deeply to the interior, and do not, as has been believed, merely glide over the surface. The apparatus used consisted of a 55 cm. spark induction coil provided with a Wehnelt interrupter and actuated by continuous current at 120 volts. The intensity of the high-frequency current was measured by means of a d'Arsonval-Gaiffe thermal galvanometer. In all the cases described (with currents ranging from 300 to 500 milliamperes) the animal died, although a human being included in the circuit in one experiment felt no sensation whatever. The smaller the animal, the sooner, *celeris paribus*, does death arrive. J. W. P.

712. *Action of High-Frequency Currents on Animals.* **d'Arsonval.** (Comptes Rendus, 133. pp. 1297–1299, Dec. 30, 1901.)—The author refers to the experiments of the preceding Abstract as completely proving his view of the action of these currents on animals. The view, that, on account of the high frequency, there is only a superficial action, is quite wrong. The deepest tissues show evidence of the action. For example, with a frequency of 500,000, the current does not show any perceptible reduction at the centre of the arms. Even from the physical point of view the old theory would be wrong for conductors having the specific resistance of animal tissue. J. W. P.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

713. *Experimental Proof of the Clausius-Mosotti Formula.* **F. Hlawati.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 454–484, May and June, 1901. From the Phys.-chem. Institute of the Vienna University.)—This work is directed to the confirmation of the expression $k/k'=(1+2v)/(1-v)$, where k and k' are the dielectric constants of a mixture, and of the purely dielectric portion of it respectively, and v denotes the volume of the conducting part of the mixture. Experiments on a great number of substances are described, and the results tabulated. The author concludes that the expression is verified within the limits of possible experimental errors. E. H. B.

714. *Electrocapillary Maxima of Organic Compounds.* **Gouy.** (Comptes Rendus, 133. pp. 1301–1303, Dec. 30, 1901.)—The author has shown previously that it is possible to measure the electrocapillary maximum of almost entirely insulating liquids. In this paper lists are given of the values obtained for solutions of many organic substances in water, and also of various organic liquids containing only traces of water. The value for pure water is taken at 1,000, and the values obtained for the various solutions are subtracted from this; the resulting number representing the depression. For solutions of substances which have not much action—for instance, of acetic acid—and which are very dilute, the depression obtained is approximately proportional to the concentration. Experiments were made on various series of organic bodies, including alcohols, amines, and acids. [See also Abstracts Nos. 2457 (1900) and 1521 (1901).] W. C. B.

715. *Wehnelt Interrupter.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 891–906, July, 1901. From the Physik. Cabinet der K.K. Universität in Wien.)—This is an extension of the article referred to in Abstract No. 870 (1901) of the author's paper. In order to find an explanation of the different effects observed when the small electrode is positive and negative, respectively, a mathematical investigation is made of a circuit consisting of a battery, a self-inductive resistance, and a Wehnelt interrupter, the interrupter having a condenser connected between its terminals. The spark-gap resistance presents great difficulty, as Ohm's law does not apply. For the author's purpose it is therefore replaced by an inductionless resistance which is supposed to be bridged across the condenser at the moment that the potential there reaches its sparking value. The conditions are found which determine whether, in such a circuit, the current at discharge shall be periodic or aperiodic, but owing to the difficulty of assigning specific values for the initial current and potential, the analysis can scarcely be applied to give quantitative results. It seems probable that the oscillatory condition of discharge at the place of interruption is to be expected when the separation between the electrode and the electrolyte is sudden. This explosive separation, and oscillatory character of corresponding discharge, the author has observed by means of a rotating mirror when the active electrode is negative. In normal circumstances, *i.e.*, with active electrode positive, the discharge is not oscillatory. By diminishing the size of the active electrode, the current remaining constant, the current density at the electrode surface is increased, and the discharge is rendered more abrupt. Using an electrolyte of dilute sulphuric acid, when the Pt active electrode is positive, there is a red glow, and a hydrogen spectrum. If, however, the active electrode is negative, the spectrum shows platinum as well as hydrogen to be present in the bubbles. Regarding now the active positive electrode as a "point," and the limiting surface, the bubble of electrolyte immediately surrounding it, as a discharging "plate," the author compares the action to the disruptive discharge mentioned by Faraday (Experimental Researches, vol. i. series xiii. § 1480 *et seq.*): Between a large ball and a small ball far longer sparks are obtained when the small ball is positive than when it is negative. In the last part of the paper the author endeavours to bring this into conformity with his own observation that the discharge in a Wehnelt interrupter is oscillatory when the active electrode is negative. R. A.

716. *Current Interrupter.* **D. Turner.** (Roentgen Ray, Archives, 6. pp. 4–5, Aug., 1901.)—The apparatus is intended as an interrupter for an induction coil, especially for Röntgen-ray work. It is a mechanical device, the contact pieces consisting of brass rollers held together by a spring. The rollers are actuated by a cam, which serves the double purpose of rotating them and of bringing them into and out of contact. When this interrupter is used in air the secondary discharges are feeble. A much better result is obtained when they are immersed in water. But by far the best effect is obtained when they are plunged into petroleum. As compared with a mercurial interrupter it is claimed that the metallic contact is more perfect; the break is more complete and sudden, owing to there being no oscillating liquid conductor; and further, the action is more rapid, the frequency, if necessary, approaching to that of the Wehnelt interrupter. For Röntgen-ray work, by the use of this mechanical arrangement, very much sharper photographs are said to be obtained, because the exposures are shorter, and consequently the secondary radiations are unable to blur the plate, and the shadows of soft parts are more evident. R. A.

717. *Current Rectifier for Röntgen Ray Work.* **R. S. Wright.** (Roentgen Ray, Archives, 6. pp. 6–7, Aug., 1901.)—The method consists in passing the alternating current unrectified through the primary of the coil, and rectifying the secondary current by providing two paths for the secondary discharge, each containing a spark-gap with ball-and-point terminals respectively, so arranged as to produce rectification by means of their selective action. [This selective action is due to the fact, noticed by Faraday (Experimental Researches, vol. i. p. 473), that between a small ball and a large one far longer sparks are obtained when the small ball is positive than when it is negative.] By placing a focus-tube in one of these paths a uni-directional discharge was obtained, the opposite current passing through the alternative gap. The resistance of the focus-tube may be balanced by arranging a longer spark-gap in the other branch, or by placing a focus-tube in each path. Tesla currents can be rectified by a similar device. For Röntgen-ray work, however, the ball-and-point arrangement did not at first give good results; "the alternations of the current itself not being sudden enough to produce a good secondary discharge." After using several forms of break, the authors fitted a Mackenzie Davidson mercury break with a motor to run synchronously, and obtained nearly perfect working. R. A.

718. *Coherer.* **F. L. Odenbach.** (West. Electn. 29. pp. 349–350, Nov. 30, 1901.)—In this paper the author describes a form of coherer which he has employed in a circuit arranged as for wireless telegraphy, to record on a revolving drum the time and duration of atmospheric electrical disturbances due to storms. On a light piece of cherrywood, 2 inches wide, 3 inches long, and ⅛ inch thick, the author places four small brass posts. Over each pair he stretches German silver or fine steel wires parallel to each other, letting them sag slightly. One pair is joined to one end of the relay circuit, the other pair to the other end. Across the gap, *i.e.*, from one span of wire to the other, he places a piece of graphite, long enough to project over the wires on each side. A. W. Faber's Siberian leads for artists' pencils H. No. 5900 were found to give the most perfect results. This form of coherer is said to be extremely sensitive. R. A.

ALTERNATING CURRENTS AND MAGNETISM.

719. *Geometrical Loci in Clock Diagrams.* **M. Schenkel.** (Elektrotechn. Zeitschr. 22. pp. 1043–1045, Dec. 19, 1901.)—In the study of most forms of alternating-current apparatus, when the connection between the various quantities has been graphically exhibited by a clock diagram, it is of great importance to know how a change in one of the quantities affects the others, *i.e.*, what curves are traced out by the extremities of the vectors when the load varies. Such a curve or locus may be determined by a point-by-point method, using a geometrical construction; but this method is very laborious. It is found that in many cases the locus is a circle or a straight line. Having stated the fundamental theorems regarding the addition, subtraction, multiplication, and division of vectors, the author points out that in many important problems the ratio ρ of two vector quantities may be expressed in terms of a variable vector x of *constant direction* by the vector equation—$\rho=(a+xb)/(c+xd)$, and shows that if one of the vector quantities remains constant, the extremity of the other traces out a circle. This circle passes through the origin if $a=0$; it becomes a straight line if $c=0$, and shrinks into a point if $a=c=0$. The author illustrates this method by applying it to a boosting transformer. A. H.

720. *Hall's Effect and its Analogues.* **E. van Everdingen, Jr.** (Archives Néerlandaises, 4. pp. 371–476, 1901.)—A full summary is given of the work done at Leyden by A. Lebret and the author since 1895, together with a general historical survey of the subject, the matters considered being: Hall's effect, dissymmetry of Hall's effect, increase of resistance in a magnetic field, difference of temperature between two secondary electrodes in a magnetic field, transversal difference of temperature across a heat-flow in a magnetic field, diminution of heat conductivity in a magnetic field, difference of potential across a heat-flow in a magnetic field, difference of potential along a heat-flow in a magnetic field. Lebret's compensation method of measuring Hall's effect, to eliminate thermoelectric and other perturbations; discussion of the possible sources of error. Dissymmetry is explained as due to a difference in the increase of resistance in two principal directions, which directions are related to the mean trend of the crystallographic axes of the metal (bismuth). An investigation is given, with mathematical developments, of the distribution of current in a circular plate of bismuth, placed in a magnetic field, and calculation of the resistances in the principal directions. The mean Hall effect is not the same when an axis of symmetry lies directly between the electrodes and when it does not; this was traced to the state of aggregation of the bismuth. With very thin electrolytically deposited bismuth the bismuth is so irregularly deposited that outside a magnetic field the metal may be considered isotropic; but in a field not at right-angles to the plate it becomes not so; in a field at right-angles to such a plate the isotropism would persist, and there could be no true dissymmetry, only an apparent dissymmetry when the secondary electrodes are not equipotential. Any appreciable thickness of such a film will introduce another cause of apparent dissymmetry, the increase of resistance along the lines of force. A plate cut from a crystal at right-angles to the principal axis would be perfectly isotropic parallel to its faces, and would act as in the last-mentioned case; if cut parallel to that axis there would be anisotropism and dissymmetry in Hall's effect. In the ordinary bismuth plate made by casting we have crystals irregularly soldered together, and there is then no determinate Hall coefficient. [See also Abstract No. 2156 (1901).] A. D.

721. *Influence of Tempering on the Decay of Magnetic Moment.* **I. Klemenčič.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 415–420, April, 1901. From the Physik. Inst. der K.K. Universität in Innsbruck.)—Following his former researches [see Abstracts Nos. 139, 1131, and 1333 (1901)] the author takes rods of silver steel, tempers them alike, then magnetises the first rod one minute after tempering, the next rod two minutes after tempering, and so on, up to intervals of sixty minutes. He watches for every bar the subsequent loss in magnetic moment. The tables show that the retentivity increases with increase of the interval mentioned. P. E. S.

722. *Permeability and Magnetic After-Effect.* **I. Klemenčič.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 421–432, April, 1901. From the Physik. Inst. der K.K. Universität in Innsbruck.)—Two questions suggested themselves to the author: (1) Has the nature of the treatment of an annealed wire any influence on its permeability? (2) Does the magnetic after-effect depend on this treatment, or is it purely a function of the annealing? The author shows by experiment that in the annealed wire (*a*) the permeability increases as the time of cooling increases; (*b*) the magnetic after-effect depends on the rate (and other conditions) of cooling; (*c*) the magnetic after-effect in the

freshly annealed specimen is less as the permeability is greater. The magnetometric method is used throughout. Tables of observations on crude and refined iron are given. [See also preceding Abstract.]
P. E. S.

723. *New Magnetographs.* **W. Watson.** (Terrestrial Magnetism, 6. pp. 187–192, Dec., 1901.)—The paper describes a set of magnetographs designed by the author for the magnetic survey of India, similar to his instruments for the determination of the disturbances of the three magnetic elements by electric railways, which are specially adapted for ready working with poor accommodation. The vertical component is not recorded in the Indian survey, but the respective instruments are also mentioned. The horizontal intensity instrument has a magnet system of nine magnets, cemented in an aluminium centre-piece which hooks on to the suspension and carries the movable mirror; the movable portion weighs 6·5 grm. The suspension is by quartz fibre. As that fibre becomes stiffer at higher temperatures, a fine phosphor-bronze strip is used for suspension in the declination instrument, and the temperature coefficient is thus reduced. But the author finds that there is a creep of the spot due to the fatigue of the metal, and he would therefore prefer quartz suspension when the magnetograph can be protected from large and rapid temperature changes, retaining the phosphor-bronze for short-period records. The temperature coefficient can also be adjusted by varying the number and nearness of the magnets. H. B.

REFERENCES.

724. *A Decimal Second in Electromagnetic Units.* **J. de Rey-Pailhade.** (Écl. Électr. 29. pp. 158–160, Nov. 2, 1901. Paper read before the Assoc. franç. pour l'Avancement des Sciences, Ajaccio, Sept., 1901.)—Values of the units are worked out on the basis of the substitution for the ordinary second as the unit of time of a decimal second having the value 1/100000 solar day = 0·864 sec. A. D.

725. *Canal-Rays in Vacuum Tubes.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 3. 15. pp. 204–212, 1901.)—A critical *résumé* of our knowledge of these rays.
R. S. W.

726. *Luminescence of Rarefied Gas Surrounding a Metallic Wire attached to a Pole of an Induction Coil.* **J. Borgmann.** (Phys. Zeitschr. 2. pp. 659–662, Aug. 17, 1901.)—Contains further details of phenomena described in Abstracts Nos. 1670 (1900) and 517 (1901). D. E. J.

727. *Energy of Electric Waves in Wires.* **M. Abraham.** (Ann. d. Physik, 6. 2. pp. 217–241, Oct., 1901.)—The author develops a mathematical theory of the propagation of electric waves along a wire (or two parallel wires). When the return is through a conducting system, he adopts the methods of E. Cohn (Das elektromagnetische Feld. pp. 471–7. Leipzig, 1900). When displacement currents also come into consideration, his methods are based on the investigations of A. Sommerfeld [see Abstract No. 570 (1899)] and G. Mie [see Abstract No. 2027 (1900)].
D. E. J.

728. *Electric Conduction in Gases.* **J. Stark.** (Phys. Zeitschr. 2. pp. 664–666, Aug. 17, 1901).—A criticism of J. J. Thomson's theory of electric conduction in gases. [See Abstract No. 1156 (1899).] D. E. J.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

729. *The Periodic System.* **H. Staigmüller.** (Zeitschr. Phys. Chem. 39. pp. 245–248, Dec. 5, 1901.)—The author constructs the following scheme, showing the position of the new gases :—

H 1	*He* 4	*Li* 7	*Be* 9·1	*B* 11	*C* 12										→	*N* 14	*O* 16	*F* 19
	Ne 20	*Na* 23	*Mg* 24·4	*Al* 27·1	*Si* 28·4										→	*P* 31·2	*S* 32·1	*Cl* 35·5
	Ar 40	*K* 39·1	*Ca* 40	*Sc* 44·1	*Ti* 48·1	*V* 51·2	*Cr* 52·1	*Mn* 55·0	*Fe* 56	*Ni* 58·7	*Co* 59	*Cu* 63·6	*Zn* 65·4	*Ga* 70	*Ge* 72	*As* 75	*Se* 79·1	*Br* 80·0
	Kr ?	*Rb* 85·4	*Sr* 87·6	*Y* 89	*Zr* 90·6	*Nb* 94	*Mo* 96·0	*Ru* 102	*Rh* 103	*Pd* 106		*Ag* 107·9	*Cd* 112	*In* 114	*Sn* 118·5	*Sb* 120	*Te* 127	*J* 126·9
	X ?	*Cs* 133	*Ba* 137·4	*La* 138	*Ce* 140													
				Yb 173		*Ta* 183	*W* 184	*Os* 191	*Ir* 193	*Pt* 195	*Au* 197·2	*Hg* 200·3		*Tl* 204·1	*Pb* 206·9	*Bi* 208		
					Th 232		*U* 240											

S. R.

730. *Standard of Atomic Weights.* **T. W. Richards.** (Amer. Acad., Proc. 37. pp. 177–181, Aug., 1901.)—It is pointed out that oxygen has actually served as the experimental standard of reference in a great majority of cases, that a great bulk of valuable work has already been published on the basis $O = 16$ ($H = 1{\cdot}0075$), and that the use of this standard involves no important difficulties in teaching, while the decision in its favour of the International Committee should ensure its adoption, since uniformity of usage is more important than any of the special advantages that have been suggested for other standards. S. R.

731. *Atomic Weight of Calcium.* **F. W. Hinrichsen.** (Zeitschr. Phys. Chem. 39. pp. 311–322, Dec. 13, 1901.)—The author has redetermined the atomic weight of calcium in calcite and has found that when $O = 16$ $Ca = 40{\cdot}142$. S. R.

732. *Intimate Structure of Crystals. Cubic Crystals with Octahedral Cleavage.* **W. J. Sollas.** (Roy. Soc., Proc. 69. pp. 294–306, Jan. 31, 1902.)—Continuing his former investigations [see Abstract No. 1144 (1901)] the author deals with the compounds cuprite, Cu_2O, tenorite, CuO, silver sulphide, and fluorspar, in which the simplest molecule contains three atoms of two kinds. If the paired atoms be approximated, but not so as to touch, and two molecules be placed at right-angles, the lower one inverted, the result will be enclosed by octahedral planes, and may be regarded as the crystalline element from which other forms are built up. Diagrams are given of the probable grouping of these primitive octahedra in the different compounds, and the dimensions are calculated from the diameters of the atoms derived from the atomic volumes. The results of geometrical construction, and also of the calculations of Mr. H. Hilton, of Magdalen College, explain many physical phenomena, such as cleavage, gyrohedry, changes of volume by heat, and varying hardness in different directions. The paper cannot be properly understood without the figures, of which there are ten. S. R.

733. *Relations of the Viscosity of Liquids to the Temperature and to Chemical Constitution.* **A. Batschinski.** (Soc. Imp. Nat. Moscou, Bull. 1. 2. pp. 1–101, 1901.)—With the object of testing the validity of the law, $\eta T^3 = E =$ a constant, η being the internal friction of a liquid, and T the absolute temperature at which the measurements are made, the author brings together the results of a large number of viscosity determinations made by various investigators. The relation is found to hold with: (1) Bromine and nitrogen dioxide; (2) 10 aliphatic hydrocarbons; (3) 20 out of 30 halogen derivatives examined; (4) 1 of 6 nitro-compounds, the data in the other cases not being very accurate; (5) 3 out of 5 sulphur derivatives; (6) 5 out of 10 aldehydes and ketones investigated; (7) 6 ethers; (8) 5 out of 13 aromatic compounds. Anhydrides, acids, alcohols, and water (below its boiling-point) in general do not obey the law, whilst of the 38 esters examined, some obey the law fairly well, and the same is the case with some others at high temperatures only, but for many of these compounds the data accessible are insufficient. T. H. P.

734. *Surface-tensions of Mixed Liquids.* **W. H. Whatmough.** (Zeitschr. Phys. Chem. 39. pp. 129–193, Dec. 5, 1901.)—The surface-tensions of liquids may be compared by determining the pressure necessary to drive a stream of air-bubbles through a capillary point immersed in the liquid. Under certain

conditions the method is capable of exceedingly great accuracy—nine out of twelve values for carbon disulphide and seven out of eight values for benzene differing by less than 0·1 per cent. from the mean ; to secure these results the capillary point must not be more than 2 cm. long, and must be of such a degree of fineness that the pressure at which bubbles are forced through the liquid is equal to that exerted by a column of sulphuric acid from 80 to 200 cm. high. The determinations are only relative ; for salt solutions the standard taken was water, $\gamma = 7\cdot557$ at 18°, and for organic liquids alcohol, $\gamma = 2\cdot413$ at 18°.

In accordance with the statement of Quincke (Pogg. Ann. 160. 337 and 500) the surface-tension of a series of aqueous solutions for chlorides was found to be expressible by a simple formula, $\gamma = 7\cdot577 + 0\cdot1857\,y$, where y is the number of equivalents of salt per 50 H_2O; by this formula the surface-tensions can be calculated within 0·1 per cent. for all solutions up to 4N, except in the case of NH_4Cl and $CaCl_2$. In the case of the sulphates the constant is 0·1585 and in the case of the nitrates 0·1535.

Quincke and Harnack have found a difference in the surface-tension of freshly prepared solutions and those that have been kept some time ; this result could not be confirmed, and the maximum deviation observed after 24 hours in six solutions was only 0·1 per cent. Volkmann has given the formula $\gamma = u_1\gamma_1 + u_2\gamma_2$ for the surface-tension of a mixture of two substances in the proportion of u_1 to u_2 ; this formula holds good for mixtures of chloroform with acetone and with ether, benzene with acetone and toluene, methylal with isobutyl acetate, and water with hydrogen chloride and nitrate ; in three cases the differences between the observed and calculated values are all less than 0·1 per cent., and in the other cases usually less than 0·3 per cent. Mixtures of sulphuric acid and water exhibit a remarkable maximum of surface-tension at 46 per cent. H_2SO_4, corresponding with a minimum of compressibility ; this is an isolated case, but minima of surface-tension occur in mixtures of acetic acid with ethyl iodide, carbon tetrachloride, benzene and chloroform, toluene with xylene, ethyl acetate with amyl alcohol, carbon disulphide with ethylene dichloride, carbon tetrachloride with chloroform, and benzene with ethyl iodide ; in a number of cases, especially where the difference between the surface-tensions of the components is large, actual minima do not occur, but curves are obtained which exhibit a marked "sag," indicating a tendency towards a minimum ; this was observed to occur in mixtures of ether with benzene and with carbon disulphide, acetic acid with water, chloroform with carbon disulphide, and benzene with chloroform and with carbon disulphide.

In the case of liquids such as water and phenol, and water and isobutyric acid, which are only partially miscible, the surface-tensions of the two layers differ considerably at low temperatures, but become identical at the critical temperature when the liquids become miscible in all proportions ; similar results were found with the two layers in ternary mixtures, such as aniline and water with ethyl alcohol. T. M. L.

735. *Gypsum and Anhydrite.* **J. H. van't Hoff** and **F. Weigert.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 48. pp. 1140–1148, Nov. 28, 1901.)—The authors find that gypsum, $CaSO_4, 2H_2O$, changes gradually at 66° C. into natural anhydrite, $CaSO_4$; but at this temperature the change is almost too slow for measurement. Certain salts, however, lower the temperature of transition ; such salts must not react, nor form isomorphous mixtures with the $CaSO_4$. For this reason the salts used in these experiments are sodium

chloride and sodium bromide. The change from gypsum to anhydrite is investigated by means of a dilatometer. The molecular volume of $CaSO_4$, $2H_2O$ is 74·3, while that of $CaSO_4$ is 47; and of H_2O, 18; so that the change of a grm.-molecule of gypsum into anhydrite causes an expansion of 8·7 c.c. A saturated solution of NaCl lowers the point of change of gypsum into natural anhydrite, from 66° C. to 30° C.; and into soluble anhydrite from 89° C. to 65° C. A saturated solution of sodium bromate changes the transition-point of gypsum to natural anhydrite, from 66° C. to 50°·2. The vapour tension of the mixture of gypsum and anhydrite at 30° C. is 24 mm., identical with that of the NaCl solution. At 50°·2 the tension is 88·3 mm. The transition-point of gypsum to the half-hydrate $CaSO_4$, $\frac{1}{2}H_2O$ is 107°, and 101°·5 under atmospheric pressure; magnesium chloride lowers the point to 11° and sodium chloride to 76°. From solutions of calcium sulphate which have a lower tension than 17·2 mm. at 25°—for instance, sea-water—the sulphate is deposited as anhydrite. [See also Abstract No. 1721 (1901).]

W. C. B.

736. *Chemical Equilibrium in the Iron-Carbon System.* **G. Charpy** and **L. Grenet.** (Comptes Rendus, 134. pp. 103–105, Jan. 13, 1902.)—In order to ascertain the influence of silicon in determining the separation of graphite from cast iron, experiments were made with iron containing a fairly constant proportion of carbon, an amount of silicon varying from 0·05 to 2 per cent., and only traces of other impurities. The conclusions arrived at are as follows: (1) The temperature at which the separation of graphite begins is lowered by the presence of silicon. (2) The separation of graphite when once started will continue at lower temperatures. (3) The rate of separation decreases as the temperature falls and as the proportion of silicon decreases. (4) In a state of equilibrium the proportion of graphite is only slightly dependent on the amount of silicon present. (5) This proportion increases with falling temperature, and at low temperatures the proportion of combined carbon *in a state of equilibrium* appears to become zero. T. M. L.

737. *Solubility of Gypsum in Aqueous Solutions of Certain Electrolytes.* **F. K. Cameron** and **A. Seidell.** (Journ. Phys. Chem. 5. pp. 643–655, Dec., 1901.)—The solubility of calcium sulphate in water (2·1 grm. per litre) is decreased by the addition of calcium chloride until with 368 grm. $CaCl_2$ per litre it is reduced to 0·03 grm. per litre, and would apparently become zero in presence of 375 grm. $CaCl_2$ per litre. Sodium sulphate, which also contains a common ion, produces at first a similar effect, the solubility falling to 1·41 grm. $CaSO_4$ per litre in presence of 16·36 grm. Na_2SO_4; but a further addition causes an increased solubility, probably owing to the formation of a double salt. Magnesium chloride and sodium chloride, which contain no common ion, increase the solubility of calcium sulphate in water, but maximum values are reached at 7·5 grm. $CaSO_4$ per litre in presence of 140 grm. NaCl, and at 8·6 grm. $CaSO_4$ per litre in presence of 121 grm. $MgCl_2$; beyond this the addition of the chloride produces a decrease of solubility, and the solubility of calcium sulphate is almost the same in presence of 400 grm. $MgCl_2$ per litre as in pure water. The presence of chalk in contact with the solution diminishes the solubility of calcium sulphate in presence of sodium chloride, especially in the more concentrated solutions; and the solubility curve shows a fairly sharp peak at 6·4 grm. per litre in presence of 0·0603 grm. $CaH_2(CO_3)_2$, and 79·5 grm. NaCl per litre in place of the smooth maximum observed in the absence of chalk. T. M. L.

738. *Distribution Ratios of Solutes.* **A. Hantzsch** and **A. Vagt.** (Zeitschr. Phys. Chem. 38. pp. 705–742, Nov. 1, 1901.)—The ratio of distribution of a solute between two solvents is found to be almost independent of the concentration and of the temperature in those cases in which the molecular condition of the solute is the same in both solvents. Values almost independent of the temperature were found in the case of mercuric chloride in water and toluene ($c_1/c_2 = 11{\cdot}20$), hydrogen cyanide in water and benzene ($c_1/c_2 = 8{\cdot}80$), ethylene cyanide in water and chloroform ($c_1/c_2 = 1{\cdot}7$), acetone in water and toluene ($c_1/c_2 = 2{\cdot}05$), formaldehyde between water and ether ($c_1/c_2 = 9{\cdot}0$), chloral hydrate between water and ether ($c_1/c_2 = 0{\cdot}234$), and between water and toluene ($c_1/c_2 =$ about 64), where c_1 and c_2 are the concentrations in grm.-molecules per litre of the solute in the first and second solvents respectively. For trimethylamine dissolved in water and toluene the ratio was found to decrease from 7·24 at 0° to 0·448 at 100°, that of triethylamine in water and toluene from 0·395 at 0° to 0·061 at 90°, that of pyridine in water and toluene from 0·840 at 0° to 0·307 at 90°, and that of collidine in water and toluene from 0·0603 at 0° to 0·0218 at 90°. This result is not due to electrolytic dissociation, which does not occur to any appreciable extent in pyridine and collidine, and in the case of trimethylamine and triethylamine is only slightly affected by temperature. It is suggested that hydrates are formed in the aqueous layer, and that these are broken up as the temperature rises; this view is supported by the fact that ethylene diamine and hydramine, which form stable hydrates, $C_2H_4(NH_2)_2, H_2O$ and N_2H_4, H_2O, remain entirely in the aqueous layer, and cannot be extracted by ether. For bromine between water and air the ratio decreases from 63·15 at 0° to 6·05 at 60°, probably owing to the decomposition at higher temperatures of the hydrate $Br_2 + 10H_2O$. The ratio of distribution of iodine in glycerol and chloroform falls from 0·675 at 0° to 0·330 at 50°, whilst in glycerol and ether it remains constant at 0·20. Probably compounds with the solvent are present in the brown solutions in glycerol and ether, but not in the violet solution in chloroform, and this view is confirmed by Vaubel's observation that solutions of iodine in dilute sulphuric acid are brown, whilst solutions in strong sulphuric acid are violet. Beckmann and Stock have shown that in all solvents the iodine molecule is diatomic. For carbon dioxide in water and air the ratio falls from 1·972 at 0° to 0.38 at 90°, whilst in toluene and air it is relatively steady at about 3·0, as is also the ratio for ammonia in toluene and air at 7·7; this is taken to indicate the formation of hydrates in the aqueous layer. For ferric sulphocyanide in water and ether the ratio *increases* as the temperature rises from 0·532 at 0° to 4·32 at 35°, and that of chromiumsulphocyanide from 0·768 at 0° to 1·720 at 30°; this behaviour is directly opposite to that of all the other substances examined, and is taken to indicate the formation of a compound with the ether. For mercuric chloride between water and toluene and for bromine between water and air the ratio is independent of the concentration, but this is not the case with iodine in glycerol and chloroform, trimethylamine, triethylamine and piperidine in water and toluene, and especially ferric sulphocyanide in water and ether, indicating that the formation of "hydrates" is in these latter cases only complete at great dilution. The additions of acids, bases, and salts has no appreciable effect on the distribution of ethylene cyanide between water and chloroform, and acids and salts do not affect the equilibrium of hydrocyanic acid in water and benzene, acetic acid in water and ether or carbon dioxide in water and air, but the distribution of monochloroacetic acid in water and ether is much affected by the addition of sulphuric acid owing to the repression of the electrolytic dissociation; this explanation cannot, however, be given in the case of the trialkylamines, in which the ratio is much reduced by the addition of alkalies but not by the addition of the amine hydrochloride to the aqueous layer. T. M. L.

739. *Oxidation of Ferrous Solutions by Free Oxygen.* **J. W. McBain.** (Journ. Phys. Chem. 5. pp. 623–638, Dec., 1901.)—The author gives the results of a number of experiments on the oxidation of solutions of ferrous sulphate, chloride, and acetate by mixing them with solutions of oxygen, the proportion of ferric ions being determined from time to time by means of ammonium sulphocyanide solution. Investigation of the oxidation of dilute sulphuric acid solutions of ferrous sulphate shows that the rate at which the action takes place is proportional to the concentration of the oxygen. The constants calculated according to the equation of reactions of the first order are very nearly proportional to the squares of the concentrations of the ferrous sulphate, even between such wide limits as N/2 and N/50; the influence of sulphuric acid on the reaction is practically nothing when its concentration lies between N/50 and N/10, but by raising the value to N/2 the constant is diminished in the ratio of about 3 : 2. The reaction must hence be regarded as trimolecular. Experiments with ferrous chloride solutions show that the velocity of oxidation is proportional to the square of the concentration of the iron in the stronger solutions, whilst for N/10 to N/50 the relation closely approaches direct proportionality; concentrated hydrochloric acid increases the rate of oxidation, but the dilute acid has no appreciable action. With ferrous acetate solutions the speed of oxidation is approximately proportional to the cube of the concentration of the salt, and the reaction appears to be tetramolecular; the corresponding acid exerts a retarding influence, which is, however, more marked than in the case of the sulphate, whilst the addition of sodium acetate greatly increases the speed of the reaction. T. H. P.

740. *Lithium Antimonide and other Lithium Alloys.* **P. Lebeau.** (Comptes Rendus, 134. pp. 231–233, Jan. 27, 1902.)—Lithium and antimony combine easily on heating with production of much heat. The author endeavoured to obtain the compound in a pure state by heating the antimony together with an excess of lithium, and after the reaction dissolving out the remaining lithium by means of liquefied ammonia. This process does not give good results, owing to the violence of the reaction. A pure product, of the formula $SbLi_3$, may, however, be obtained by the electrolysis of a fused mixture of equal quantities of LiCl and KCl, using a graphite anode and an antimony kathode. The compound is of perfectly definite composition, highly crystalline, and acts on water in the cold with production of pure hydrogen; its melting-point is much higher than those of its constituents. This electrolytic method may be employed to produce various lithium alloys, and antimonides and arsenides of the other alkaline metals. W. C. B.

741. *Alloys of Aluminium with Iron and with Manganese.* **L. Guillet.** (Comptes Rendus, 134. pp. 236–238, Jan. 27, 1902.)—An examination of the iron-aluminium alloys obtained by heating aluminium with ferric oxide led to the isolation of the crystalline compound Fe_2Al_3; this corresponds in composition to the maximum point in Roberts-Austen's fusibility curve. A further crystalline alloy, $FeAl_3$, and similar manganese compounds, Mn_3Al_3, $MnAl_3$, and $MnAl_4$, were isolated. D. H. J.

742. *Pure Seleniuretted Hydrogen.* **de Forcrand and Fonzes-Diacon.** (Comptes Rendus, 134. pp. 171–173, Jan. 20, 1902.)—The gas was obtained pure and dry by the action of water on excess of aluminium selenide. It was soluble in water to the extent of 3·77 vols. at 4°, of 3·43 vols. at 9°·65, of 3·31 vols. at 13°·2, of 2·7 vols. at 22°·5. Liquid H_2Se has a density of 2·12 at its boiling-point, $-42°$; at low temperatures it changes to a white solid of melting-point $-64°$. D. H. J.

743. *Vapour Tension of Hydrogen Selenide and Dissociation of its Hydrate.* **de Forcrand and Fonzes-Diacon.** (Comptes Rendus, 134. pp. 229–231, Jan. 27, 1902.)—The vapour tension of H_2Se is known to be 760 mm. at $-42°$ C. By using Cailletet's apparatus the authors find the tension at 0°·2 C. to be 4·5 atmospheres, and at 30°·8 C. to be 12 atmospheres. In order to obtain the tension at another point the gas was put into the shorter arm of a Boyle's tube, which was cooled to $-30°$ C. by a bath of liquid methyl chloride through which a current of air was passed; the pressure found was 1·75 atmospheres. From these four values the curve may be constructed and the heat of vaporisation of H_2Se obtained; this is found to be 4·74 calories. The hydrate may be obtained by filling a flask with damp hydrogen selenide, and exposing it to a temperature of about 5° C. It is a colourless crystalline substance of about the same stability as chlorine hydrate. Its tension of dissociation was measured at several temperatures. W. C. B.

744. *Spontaneous Decomposition of Ozone.* **E. Warburg.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 48. pp. 1126–1139, Nov. 28, 1901.)—The proportion of ozone in ozonised oxygen gradually diminishes on standing. This decomposition may be due to traces of impurities, or to the instability of the ozone molecule; in the latter case each ozone molecule may break down independently of the others, when the reaction will be monomolecular; or two molecules may react so as to produce mutual decomposition, in which case the action will follow a bimolecular course. The apparatus used is similar to that employed by the author in a former research [see Abstract No. 2067 (1900)], the chief difference being that the ozone is only allowed to come into contact with glass and sulphuric acid, and not with platinum as in the earlier experiments. The apparatus consists essentially of two glass vessels of equal size, connected by a capillary U-tube containing a thread of sulphuric acid. Before the gas in one of the vessels has been ozonised, the level of the H_2SO_4 is the same in each limb of the capillary; the amount formed can be calculated from the contraction, and the rate of spontaneous decomposition from the gradual return of the thread of acid to its original level. Series of experiments were made at 17° C., 100° C., and 126°·9 C., sulphuric acid, soda-lime and phosphorus pentoxide being used as drying agents. It is found that the drying agent used exerts no influence on the stability of the ozone, except that commercial phosphorus pentoxide, owing to the presence of lower oxides, rapidly destroys the ozone; when purified by distillation over red-hot platinum it loses this property. The author finds that at a low temperature (17° C.), the velocity of spontaneous decomposition is small compared with that due to impurities in the ozone, but that as the temperature is raised the former velocity quickly increases. The reaction is bimolecular, and proceeds according to the following equation: $dC = -\beta_1 . C^2 . dt$ where $C =$ the mass of ozone in grammes per litre; t is the time in minutes, and β_1 a value depending on the temperature. B_1 has the value 0·00000204 at 17° C., 0·0157 at 100°, and 0·177 at 126°·9 C. It is impossible to obtain any further alteration

in volume by raising the temperature of ozonised oxygen which has been heated to 180° C.; but oxygen, at a temperature of 200° C., may be ozonised to the extent of 1·5 parts per mille by means of an induction apparatus. Finally the author examines Shenstone's statement that dry ozone is less stable than the damp gas (Chem. Soc., Jour. p. 477, 1897) by placing ozone in contact with a diluted sulphuric acid of the formula $H_2SO_4 + H_2O$. His results, at a temperature of 100° C., do not agree with those of Shenstone.

W. C. B.

745. *Alkalichloride Electrolysis with Carbon Anodes.* **L. Sproesser.** (Zeitschr. Elektrochem. 7. pp. 971–976, Nov. 7; 987–994, Nov. 14; 1012–1017, Nov. 21; 1027–1035, Nov. 28; 1071–1076, Dec. 12; and pp. 1083–1093, Dec. 19, 1901. Communicated by the Elektrochem. Labor. of the Dresden Institute.)—As the production of good carbon anodes is of great importance in the technical electrolysis of alkali chlorides, the author has made a comparative research on the general properties of various forms of carbon, and on their behaviour when used in electrolysis. The following varieties were used: three sorts of retort carbon, seven of manufactured anodes, and one variety of graphite. The true specific gravity varied from 2·07 to 2·10 for the retort carbons, and the apparent sp. gr. from 1·71 to 1·86. For the artificial carbons the true sp. gr. ranged from 1·94 to 2·08, and the apparent sp. gr. from 1·47 to 1·64; from the ratio of the real to the apparent sp. gr. the author determines the porosity of the carbon. Determinations of the ash left on combustion are also given. The carbons used as anodes were plates 7 cm. long, 4·5 cm. broad, and 1 cm. thick; two platinum plates 6 × 2·5 cm. served as kathode. The electrolytic cell was a beaker containing about 250 cub. cm. of a solution of KCl, 200 grams per litre; in later experiments this was replaced by a solution of NaCl, 200 grams per litre, to prevent separation of the chlorate. The cell was provided with an apparatus for collecting the gases evolved, and was placed in circuit with a copper sulphate, a water voltameter, and an ammeter. A large number of experiments were made with the different carbons, under varying conditions of temperature, current, and concentration of the electrolyte. Control experiments were also made with platinum anodes. Tables are given showing for each experiment the oxygen and CO_2 evolved, and the hypochlorite and chlorate produced. The total active oxygen produced is greater with platinum than with carbon, as the carbon is always attacked to some extent with production of CO_2; the amount of this attack varies considerably, from 8 per cent. for the retort carbons to 19 per cent. for the manufactured anodes. The losses of anodes composed of the different carbons by precipitation of carbon, and by solution and evolution of CO_2, is also tabulated. A further section of the research deals with electrolysis in cells containing a porous clay diaphragm. The author also shows that the liberation of gases, due to the porosity of the carbon, is not the principal cause of the breaking up of the carbon, but that this is due primarily to chemical actions. The destruction of the anodes was more rapid at higher temperatures. The best anodes are generally those composed of the least porous carbons, but it is not possible to judge of the suitability of a carbon simply from its porosity. Researches on the electrolysis of various other solutions with carbon electrodes, and on the oxidation of carbon by hypochlorous acid are also given. The author concludes with a summary of the various methods of testing carbons with reference to their use as anodes in alkalichloride electrolyses.

W. C. B.

746. *Electrolysis of Fused Salts.* **R. Lorenz.** (Electro-Chemist, 1 pp. 267–268, Dec., 1901.)—The author criticises some of Garrard's results on electrolysis of fused salts, particularly fused $\mathrm{PbCl_2}$. The latter found two "kink" points in the decomposition voltage curve of fused $\mathrm{PbCl_2}$, and one in the case of salts of the type of AgCl. The first point occurs at 0·8 volts (temperature 600° C.), and, according to Garrard, corresponds with the equation (1) $\mathrm{PbCl_2} = \overset{++}{\mathrm{Pb}} + \overset{-}{\mathrm{Cl}} + \overset{-}{\mathrm{Cl}}$; the second at 1·2 volts with the equation (2) $\mathrm{PbCl_2} = \overset{+}{\mathrm{Pb}}\mathrm{Cl} + \overset{-}{\mathrm{Cl}}$. The author considers that the first point is caused by depolarisation phenomena, and that the second corresponds with equation (1). If the first point corresponds to equation (1) it should be independent of experimental conditions; this, the author finds, is not the case. By placing the electrodes near together, the depolarisation and the diffusion of metal in the form of "fog" [see Abstract No. 425 (1901)] increase, and the point may fall to 0·6 volt; by increasing the distance apart of the electrodes the value increases, until the "kink" point disappears from the curve. When there is only one point at 1·2 volts the current yield is 100 per cent., when there are two it is always less. This e.m.f. of 1·2 volts is also identical with the e.m.f. of polarisation on electrolysing $\mathrm{PbCl_2}$, and with the e.m.f. of a cell containing carbon | chlorine gas | fused $\mathrm{PbCl_2}$ | lead. For these reasons the author concludes that the second "kink" point of Garrard's curve corresponds to the reversible reaction of equation (1). Adopting certain conditions, the author deduces from the first law of thermodynamics his empirical formula $\epsilon/\epsilon_0 = a$, where a is the current yield and ϵ_0 and ϵ the counter electromotive forces. He shows that the principle that ϵ (the counter e.m.f. in the electrolytic bath) is proportional to a is applicable to the commercial electrolytic production of potassium, sodium, and magnesium, and to the Héroult cell for the production of aluminium. This principle also explains the increased yield obtained by cooling the kathode, and by adding certain substances; in both cases the solubility of the metal and the tendency to form "fog" are diminished, the polarisation is diminished, and the current yield consequently increased. These metal "fogs" also explain the various suboxides and subchlorides said to form at the kathode; in reality these are simply metal solutions in the electrolyte. Finally the diffusion of metal in this form explains the results of electrolysis with diaphragms, through many of which the metal "fogs" are unable to pass. [See also Abstract No. 2225 (1901).] W. C. B.

747. *Passive Iron.* **A. Finkelstein.** (Zeitschr. Phys. Chem. 39. pp. 91–110, Nov. 12, 1901.)—An electrode of passive iron can be balanced in a Wheatstone bridge with an alternating current of small magnitude by means of a condenser of large capacity short-circuited with a very small resistance; it therefore behaves very much like platinum and gold, and its special properties cannot be due to a non-conducting film of oxide. There is a definite e.m.f. at which an iron anode becomes passive; this is independent of the acidity of the solution, and depends only on the amount of iron in the solution, affording fresh evidence that the passivity is not due to a layer of oxide. The view adopted is that passive iron is a metallic modification of the element, which resembles the noble metals and is capable of absorbing oxygen.
T. M. L.

748. *Structure of the Atom and the Ionic Theory.* **F. Lengfeld.** (Journ. Phys. Chem. 5. pp. 639–642, Dec., 1901.)—The author discusses the bearing on the ionic theory, the solution tension theory, and the periodic law of

J. J. Thomson's work on the structure of the atom. Thus sodium chloride may dissociate into chlorine atoms plus one corpuscle and sodium atoms minus one corpuscle, and it may be supposed that in electrolysis the chlorine ion may be neutralised at the anode, the neutral atom of n corpuscles being stable, but that of $n+1$ unstable, and the extra corpuscles set free may diffuse through the solution and at the kathode add on to the sodium ions, or replace in the kathode the corpuscles that have been taken up by the sodium ions. He suggests in explanation of the fact that a metal plate becomes negative when placed in water, that diatomic metal molecules may go into solution, and there split up into positive ions (1 atom minus 1 corpuscle) and negative ions (1 atom plus 1 corpuscle), and that the negative ions may be less soluble than the positive deposit on the zinc. Lastly, regarding the arrangement of the corpuscle in the atom as that of Mayer's group of magnets floating in a magnetic field, each atom is made up of nucleus and periphery, and certain properties, *e.g.*, group properties, may depend on the shape, &c., of the nucleus, others on the periphery. [See also Abstract No. 1294 (1900).]
W. E. T.

749. *Luminous Phenomena at Aluminium and Magnesium Electrodes.* **S. A. Berti.** (Elettricista, Rome, 11. pp. 1–2, Jan., 1902.)—When a solution of sodium potassium tartrate is electrolysed between aluminium electrodes, there ensues (at the anode with a direct current, at both electrodes with an alternating current) a fluorescence which at 250 volts changes to an appearance of continuous luminosity. The author ascribes the effect to the formation of a badly conducting layer of oxide on the electrode, shows that magnesium may replace the aluminium, and identifies the phenomenon with that observed by Tommasina [see Abstract No. 498 (1900)] during the discharge of an induction coil through alcohol or water. Instead of the tartrate, other solutions may be used, viz., dilute potash, soda, or ammonia, carbonate and phosphate of potash or of sodium, potassium bichromate, and ammonium carbonate.
D. H. J.

REFERENCES.

750. *Comparison of Notations Employed in "Theories of Crystal Structure" and Revision of the 230 Groups of Movements.* **H. Hilton.** (Phil. Mag. 3. pp. 203–212, Feb., 1902.)

751. *Properties of Steel Castings.* **J. O. Arnold.** (Metallographist, 5. pp. 2–24, Jan., 1902. Paper read before the Iron and Steel Institute, May, 1901.)—The paper deals very fully with the physical and chemical questions affecting this very complex subject.
O. J. S.

752. *Apparatus for Determination of the Motion of Ions.* **R. Abegg.** (Phys. Zeitschr. 3. pp. 110–112, Dec. 15, 1901.)—The article describes an apparatus for demonstrating and measuring the velocity of the surfaces of separation of a jelly-electrolyte and liquid electrolytes. The apparatus consists of an electrolyte tube, with two electrode bulbs, arranged in a glass tank. Its use is explained in detail.
G. H. B.

753. *Electrochemistry.* **H. C. Jones.** (Elect. Rev. N.Y. 39. pp. 65–68 ; 93–97 ; 121–124 ; 150–152 ; 182–185 ; 209–213 ; 273–277 ; 303–307 ; 339–342 ; 372–376 ; and pp. 402–405, 1901.)—A series of articles giving a clear account of the ionisation theory and its foundations, more particularly with reference to voltaic cells.
W. R. C.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

754. *Engines for Large Traction Plants.* **W. Kent.** (Street Rly. Journ. 18. pp. 293–309, Oct., 1901.)—The three plants referred to are those of the Metropolitan Street Railway Company, the Third Avenue Railway Company at Kingsbridge, and the Manhattan Railway Company. [See Abstracts Nos. 1378 (1900) and 977 (1901).] The primary consideration in such large stations is continuous operation, running economy coming next, and first cost last. The use of Corliss valves on the high-pressure cylinders of the engines used in these plants prevents the utilisation of superheated steam, while those for the low-pressure cylinders are of enormous size, difficult to lubricate, and, being unbalanced, probably require considerable power to operate them. The author compares these types of engines with marine engines, such as those to be used on H.M.S. *King Alfred*—two engines, triple expansion, four cylinders, 43½, 71, 81, 81 in. dia. by 48 in. stroke; 120 r.p.m., steam pressure at engines 250 lbs. per sq. in., rated h.p. 15,000. There seems to be no good reason why such engines as these should not be well adapted for a power station; they would develop about 11,000 h.p. at the most economical rate, and a maximum of about 16,500 h.p., while the engines are in fact smaller than the Manhattan ones, though of 37½ per cent. greater power. The running conditions of such an engine driving an alternator on land would be much less severe than those of a marine engine. The general conditions required of the latter are that it must be of minimum weight and occupy minimum space for the power required, it must economise fuel to the highest degree, must be balanced, as its only foundation is the hull of the vessel, must be capable of running for eight days and nights without stopping, and must run with very little oil. These power stations have engines of great size and weight per h.p.; slow rotative speed, involving large size and cost of alternators, extensive foundations, and waste of space; unbalanced rotating valves; low steam pressure without superheating; only two stages of expansion, and a maximum economy of 13 lbs. of steam per i.h.p.-hour. The author considers that an engine on the lines of the best marine practice, running at not less than 100 r.p.m., would do the work for between 10 and 11 lbs. of steam per i.h.p.-hour, and that such engines are likely to be adopted before long in large power stations, when the engines of these three large plants may come to be regarded as magnificent examples of a transition period in power-plant engineering. H. R. C.

755. *Power for Driving Marine Engine Works.* **J. Crighton** and **W. G. Riddell.** (Inst. Mech. Engin., Proc. 4. pp. 959–973; Discussion, pp. 974–976, Sept., 1901.)—The costs of driving the main shafting, gearing, and machine tools, and the electric lighting apparatus of an engineering works by means of two different installations—an old and a new one—are compared. The basis of comparison is the cost of removing one ton of metal by machines, and this is arrived at by taking the weight of all turnings, &c., for a fixed period, and dividing this by the cost of one h.p. for the same period.

The old installation of power plant comprised one marine-type boiler working at 80 lbs. per sq.-in. pressure (the feed-water being heated to 205° F.), and supplying steam to three vertical compound non-condensing engines for driving shafting and machines, and one vertical compound engine for lighting. The new set has one Scotch marine boiler with three furnaces, working pressure 200 lbs. per sq. in., and one vertical double-acting compound engine worked non-condensing. Forced draught is used, and the feed-water is heated to 205° F. by an exhaust steam heater.

The three engines under the old system collectively developed 151·2 i.h.p., and the lighting engine 64·66 i.h.p. The boiler evaporated 6·75 lbs. water per lb. coal, and the engines used 43·8 lbs. water per i.h.p.-hour. This gave a coal consumption of 6·4 lbs. per i.h.p.-hour.

The new boiler has 2,040 sq. ft. heating surface and 46·2 sq. ft. grate area, and an equivalent evaporation of 11·5 lbs. water from and at 212° F. has been frequently maintained. The engine developed 147·27 i.h.p. when driving the electric light apparatus alone; 61·75 i.h.p. when driving only the line shafting and loose pulleys; 141 i.h.p. when the machines and countershafts were added, and 210 i.h.p. when the machines were cutting at normal rate.

The line shafting (2,300 feet long, 3¼ in. dia., weighs 37 tons 8½ cwts., and runs at 140 to 150 revs.) absorbs 29·3 per cent. of the total power, countershafts and machines 67 per cent., and only 33 per cent. is applied to the cutting tools.

Various kinds of coal were tried, and the best results were obtained with steam coal at 11s. 6d. per ton. The ascertained costs were as follows:—

	Old system.	New system.
Material removed per annum	245 tons	367 tons
„ „ per i.h.p. per annum...	1·61 „	1·74 „
Cost of removing 1 ton of material	£5·21	£2·48

In the discussion **A. Saxon** considered the friction of engine and shafting rather high. An economiser heating the feed to 250° or 300° would give improved results. **W. H. Allen** found that 25 per cent. was taken up in the shafting, 25 per cent. in the top gearing, the smaller tools requiring 30 per cent., and the larger tools 20 per cent. of the energy given out by the generator in an engineer's shop, so that the work done in actual cutting was not more than 25 per cent. Some of this waste could be abolished by using the clutch system. **J. Crighton,** in reply to **B. Donkin,** stated that the boiler efficiency varied from 68 to 73 per cent.—as high as 78 per cent. had been attained. F. J. R.

756. *Modern Boiler Problems.* **E. D. Meier.** (Power, N.Y. 21. pp. 28–29, Dec., 1901. Paper read at the meeting of the New England Cotton Manufacturers' Assoc., Sept., 1901.)—Increased demand for, and altered conditions of, steam-power have rendered departure from formerly recognised standards necessary. Furnace capacity and efficiency can no longer be confounded with boiler capacity and efficiency, just as the boiler must now be considered apart from the engine. Modern conditions include the combustion of 25 lbs. with natural, and 35 to 50 lbs. with forced, draught per square foot of grate area per hour; steam pressures of 150 to 200 lbs. per square inch and even more, and feed-water temperatures very much above the old 100° or 110° F. The range of qualities of fuel to be used is also much greater; even the different grades of size of good coal produce different results. Thus good bituminous produces 7·1 h.p. per square foot of grate; anthracite egg 5·8, pea coal 4·4, buckwheat coal, 3·6, and rice coal 3 h.p. As length of grate is limited even with mechanical stokers, width becomes the measure of power

with low-grade fuels. Heating surface must be disposed to meet such a requirement. The high steam pressures render large diameters and all collapsing stresses undesirable. Great economy demands high furnace temperatures and ample combustion space so that the gases are not quickly cooled by the heating surface. These and other considerations point to the suitability of water-tube boilers as compared with either internally fired or externally fired cylindrical shell boilers. F. J. R.

757. *Size of Lever Safety Valves.* **R. A. Douglass.** (Amer. Electn. 14. pp. 14–17, Jan., 1902.)—The rules for determining the proper size of safety valves to be used on any given boiler are not in a very satisfactory state, neither the actual "lift" of safety valves nor the actual rate of discharge of steam through them being clearly known. Properly speaking, a safety valve should be competent to discharge steam at the maximum rate at which the boiler can produce it, but elements are wanting to enable such a valve to be designed. The valve seat being conical, the vertical lift of the valve must be multiplied by the sine of the angle made by the surface of the seat with the vertical centre line of the valve, in order to obtain the width of the ring formed by the opening of the valve by a given lift. The author gives in tables the results of experiments on the extent of lift of lever safety valves at pressures from 10 lbs. to 100 lbs. per square inch, made by the U.S. Board of Supervising Inspectors, and also figures giving the effective discharge areas of valves of different diameters at these pressures, on the assumption that the angle referred to is one of 45°. Taking Napier's rule for outflow of steam through an orifice as applicable to valves (which is not strictly true) he finds that at the various pressures (in lbs. per sq. in.) the following shows the number of lbs. of steam discharged through an orifice 1 inch square in one minute :—

Gauge pressure :	10,	20,	30,	40,	50,	60,	70,	80,	90,	100lbs.
Steam discharge :	21·4,	30·0,	38·6,	47·1,	55·7,	64·3,	72·9,	81·4,	90·0,	98·6lbs.

From these data a table is given showing pounds of steam discharged per minute by lever safety valves of different diameters at the different pressures. This table reveals some anomalies which call for experimental research.

F. J. R.

758. *Transfer of Heat from Steam to Water.* **H. L. Hepburn.** (Power, N.Y. 21. pp. 18–20, Dec., 1901.)—Whilst the thermal conductivity of thin partitions of iron or copper may be dealt with as if the conductivity of the metal were infinite, that of water is so low that a sheet of it ½ inch thick will transmit only about 12¾ B.Th.U. per square foot per hour per deg. difference of temperature between the two faces. The particles of water, however, take up heat very rapidly when in contact with the hot body, consequently in the absorption of heat from a metallic surface by water in contact with it, the amount of stirring or the velocity of the water over the heating surface is an essential factor. Dealing with the formula proposed by C. P. Poole : $W \log_e (T_s T_e)/(T_s T_d) = AU$, in which W=number of lbs. of water per hour ; A = square feet of transmitting surface; U = B.Th.U. absorbed by the water per square foot of surface per deg. of temperature difference per hour ; T_s = temperature of the hot surface ; T_e = temperature of entering water ; T_d = temperature of discharge water ; H = total number of B.Th.U. absorbed by the water per hour ; the author shows that the average difference of temperature throughout the time of an experiment will be less than that usually supposed, viz. : $T_s-(T_o+T_d)/2$. Consequently, the usual formula $AU\{T_s-(T_o+T_d)/2\}=H$ does not provide for the increasing increment of surface required for each additional degree to which the discharged water is raised, the cost of such addition becoming practically prohibitive when the final temperature approaches 7 or 8 degs. of that of the heating medium. With Poole's formula, taking W as unity, all problems in heater work may be readily worked out in connection with a proper value of U, with given values of T_s, T_o and A; T_s, T_o and T_d; T_s, T_d and A; or T_o, T_d and A. Taking $U=350$ B.Th.U., and $T_s=216°$ F., and deriving values of A for several values of T_o and T_d, the following gives the—

AREA OF HEATING SURFACE REQUIRED TO HEAT ONE POUND OF WATER PER HOUR.

Temperature of Entering Water (T_o).	Temperature of Leaving Water (T_d).			
	210°	205°	200°	195°
60°	0·009309	0·007578	0·006507	0·005730
70°	0·009119	0·007384	0·006316	0·005539
80°	0·008916	0·007186	0·006115	0·005344

In another table the author gives the results of experiments of *Nichols*, *Stanton*, *Richter*, *Hildreth*, and some by himself, worked out according to Poole's formula, and in a diagram several of these are plotted. The original paper should be consulted for these data.

Good American practice allows 1 square foot of surface in condensers for every 10 lbs. of steam to be condensed per hour at a vacuum of 25 inches of mercury and an initial temperature of 75° F. for the cooling water. About 25 lbs. of water per lb. of steam is allowed, and the condensed steam is reduced to a temperature of about 120° F. This amounts to heating 25 lbs. of circulating water from 75° to 116° F. per one-tenth square foot of surface per hour with steam at 133° F. By Poole's formula this gives $U=306{\cdot}67$. Taking into account the surface required to reduce the temperature of the condensed steam to 120° F. the value of U becomes 328·5 approximately, which corresponds with American practice in designing heaters. F. J. R.

759. *Heating Surface of Feed-water Heaters.* **J. E. Lewis.** (Power, N.Y. 21. pp. 30-31, Dec., 1901.)—Experiments made by Isherwood in 1867 showed that if the thermal conductivity of copper be taken as unity, that of brass is 87 per cent., wrought iron is 58 per cent., and cast iron 49 per cent. ; and that expressed in B.Th.U. these become copper 642, brass 557, and wrought iron 374. To calculate the surface required in feed-heaters, a formula is used in which these figures are modified by a constant to meet practical conditions. Thus $S=WD/ck\,(T-t)$ where S = the surface in square feet ; W = pounds of feed-water per hour ; D = the difference between the temperature of water on entering and leaving the heater ; T = temperature of steam in deg. F. ; t = mean temperature of the water ; k = Isherwood's value for the conductivity of the metal composing the heating surface, and c is a constant qualifying k. Loring and Emery made experiments on the U.S.S. *Dallas*, which gave c a value of 0·323 for condensers. Adopted for feed-heaters, this makes ck for copper

$642 \times 0{\cdot}323 = 207$, for brass $= 180$, and for wrought iron $= 120{\cdot}8$. In a 500-h.p. non-condensing plant, if the quantity of feed-water to be heated per hour from 50° to 212° F. is 500 × 30 lbs. per h.p. = 15,000 lbs., then $D = 212 - 50 = 162$; $T = 212$ and $t = 50 \frac{162}{2} = 131$; $T - t = 212 - 131 = 81$; and $S = \frac{15{,}000 \times 162}{207 \times 81} = 145$ sq. ft., or 42 sq. in. per h.p. for copper. For brass this becomes 167 sq. ft. or ⅓ sq. ft. per h.p.; and for wrought iron 250 sq. ft. or ½ sq. ft. per h.p. Approximately, when the water is heated to the temperature of the steam, the surface can be calculated by dividing W by a constant $\frac{ck}{2}$, which is = 100 for copper, 90 for brass, and 60 for wrought iron. A quick rule, therefore, for computing the heating surface, knowing the amount of feed-water, and assuming that there is sufficient steam for the work, is to divide the feed-water in lbs. per hour by 100 for copper, 90 for brass, and 60 for iron coils. These results apply only to the water-tube heater.

F. J. R.

760. *Evaporative Surface Condensers.* **H. G. V. Oldham.** (Feilden, 6. pp. 107–120, Feb., 1902.)—Since steam users have learned the value of condensing plants, efforts have been directed towards simplifying the apparatus and minimising the loss of cooling water. The author reviews the progress made in this respect since his former paper [see Abstract No. 295 (1900)], and gives data and illustrations of several installations of successful evaporative condensers. It has been found that 2 lbs. of steam can be condensed per square foot of tube surface per hour without the use of water, but with air passing over the surface at a velocity of 1,000 feet per second. About 2,400 cub. ft. of air would be required for 1 lb. steam, 100 h.p. (at 20 lbs. steam per h.p.) requiring 1,000 sq. ft. of surface and 80,000 cub. ft. of air per minute. Without the use of a fan and without water, 125 sq. ft. would be required per lb. of steam condensed per minute, as against the above 30 sq. ft. per lb. steam per minute with a fan. When water is used, evaporative condensers are at work in which 2 sq. ft. of surface suffice per lb. of steam. These condensers necessarily have more surface than ordinary surface condensers, but the latter use about ten times the quantity of condensing water. In the case mentioned, the evaporative condenser had 3,000 sq. ft. of tube surface, and condensed all the steam from an engine indicating 50 h.p. which, taking 30 lbs. steam per i.h.p., gives a total of 1,500 lbs. steam per hour. Both vertical and horizontal tubes are employed in construction—the former came into use for condensers taking up small space, and not requiring more water than the ordinary supply for boiler-feed. Details and diagrams are given of the Thiesen, Wright, and Fraser condensers; and also of the horizontal and vertical open type, with either cast or wrought iron and copper tubes, which was introduced on account of difficulties connected with cleaning and working the vertical brass tube condenser. The open type occupies more space than the other, requiring about 1 sq. ft. of floor-space per 2 to 3 h.p. and a height of 10 ft. With wrought-iron tubes, 1 sq. ft. of surface will condense 2 to 3 lbs. steam per hour, with cast iron about 1¼ lbs. steam. The horizontal tube condensers of Ledward, Fraser, Kirkcaldy, and Cooper and Grieg are well illustrated, and details of several installations are given. Two plans are also given as typical of the latest practice for stations specially designed. The article concludes by noticing some important precautions to be observed in order to secure successful working.

F. J. R.

761. *Refuse Destruction.* **J. A. Priestley.** (Mech. Eng. 8. pp. 770–774, Dec. 7, 1901. Paper read before the Congress of the Royal Institute of Public Health, 1901.)—This paper describes the Meldrum destructor installed at Nelson, in combination with a Lancashire steam boiler, and a regenerator consisting of vertical cast-iron pipes through which the waste hot gases travel, which is placed in the circuit between the boiler and the chimney for the purposes of heating the air used for combustion. A record of tests made with the apparatus is given, Callendar's electrical recording pyrometer having been used for the temperatures, charts of which accompany the article. The CO_2 in the escaping gases was estimated by Orsat's apparatus at frequent intervals. The steam pressure in the boiler averaged 122 lbs. per square inch on an eight-hours' test, the fluctuations having been between 110 and 130 lbs.; the temperature of the combustion chamber ranged between 1,666° and 2,693° F., the average being 2,227° F.; and the CO_2 averaged 14·4 per cent., the maximum reading having been 19·8 per cent. The temperature of escaping gases was, however, 666° F., which, if utilised in an economiser, might have added 18 per cent. to the total evaporation. The total weight of water evaporated was 91,600 lbs. from feed at 83° F., giving an actual evaporation of 1·67 lbs. water per lb. refuse, or 1·96 lbs. from and at 212° F. The average hourly evaporation was 1,344 gals. from and at 212° F., which is said to have been equivalent to 13·6 lbs. of water per square foot of heating surface per hour. The refuse had a value, therefore, for steam raising of one-fifth that of coal. F. J. R.

762. *The "Potter" Mesh Separator.* **F. A. Scheffler.** (Power, N.Y. 21. p. 20, Dec., 1901. Presented at the New York meeting of the A. S. M. E., Dec., 1901.)—This device consists of a series of copper or galvanised wire meshes or screens placed vertically, and alternating with rings of cast iron, so that there is a small chamber or space between the meshes. There are usually 25 to 30 layers of mesh, which are held together by horizontal bolts passing through the series, but the area of the screens depends on the size of steam outlet from the boiler. The separator is placed in the steam space, one end exposing the screen to the steam. At the other end is a chamber from which a vertical steam-pipe leads. This is perforated in the portion which is inside the chamber, so that the steam after passing through the entire series of screens reaches and escapes by the pipe. Besides arresting any water, or filtering it out from the steam, there is a slight wire-drawing action, amounting to about 1 per cent. reduction of pressure, and a consequent slight superheating which further dries the steam. In any case it seems impossible for any priming water to escape through this device. Tests made on a 3,000-h.p. electric plant with and without the separator showed a decided advantage from its use. F. J. R.

763. *Water-hammer Steam-pipe Explosions.* **C. E. Stromeyer.** (Manchester Lit. and Phil. Soc., Mem. 46. 3. pp. 1–16, 1901–1902.)—Fracture by water-hammer may happen when water collects in the steam-pipe near the boiler stop-valve, as in that case, when the stop-valve is opened a plug of water is shot along the pipe to the engine, and will either break the valve there or the pipe. The author investigates the effect of sudden stoppage of an elastic body, and gives the formula $P = EV/W$ for the pressure exerted by it, and $t = L/W$ for the duration of the pressure, W being the velocity of sound in the body, E the volume elasticity, V the velocity suddenly destroyed, and L the length of the body. H. R. C.

764. *Cooling Towers.* **C. W. Obert.** (Amer. Electn. 13. pp. 475–478, Oct., 1901.)—The paper contains a description, with diagrams, of various commercial forms of towers used for cooling the condensing water of steam engines so that, with a small percentage loss by evaporation, the same water can be used over and over again. The water is made to fall in finely divided and broken-up streams, and may be cooled simply by falling through the air, or there may be an upward draught in the tower produced either by a fan or by connection to a chimney. All three types are illustrated. H. R. C.

GAS AND OIL ENGINES.

765. *Japy Motor.* **P. Sarrey.** (Locomotion Automobile, 9. pp. 54–56, Jan. 23, 1902.)—This is a stationary four-cycle internal-combustion engine which has been run very successfully on alcohol fuel. It has a single horizontal cylinder 14·5 cm. bore × 16 cm. stroke, water-cooled. The induction valves are automatic and the exhaust mechanically operated. The carburettor is of the float-feed spraying type, with a special arrangement of baffles for breaking up the spirit sucked out of the jet; it is mounted close up to the induction valve box. With pure commercial alcohol, 3·75 b.h.p. is developed at 300 r.p.m. on a consumption of 2 kg. 15 per hour. With 50 per cent. alcohol, 3·76 b.h.p. is developed at 300 r.p.m. on a consumption of 1 kg. 54 per hour. Several illustrations are given of this engine, and a photograph of a double-cylinder vertical engine for motor cars. C. R. D'E.

766. *Balzer Revolving Cylinder Engine.* (Horseless Age, 9. pp. 141–142, Jan. 29, 1902.)—This is a five-cylinder internal-combustion engine in which the crank-shaft is fixed and the cylinders revolve and constitute the flywheel. The cylinders are single-acting, air-cooled. They have mechanically operated inlet and exhaust valves. Electric ignition is employed. Ten h.p. is developed at 500 r.p.m., and the engine weighs 300 lbs. C. R. D'E.

767. "*Loyal*" *Cooler.* (Locomotion Automobile, 9. pp. 40–41, Jan. 16, 1902.)—The cooler, which is for use in motor cars, consists of a number of small tubes connected at inlet and outlet to a single large tube. Around the small tubes are mounted corrugated radiating ribs. The outline of the cooler is such that it will fit into the ordinary motor bonnet at the front of the car frame. The lengths of the compound tube required per h.p. are, with nine small tubes, 45 cm.; with thirteen tubes, 30 cm.; and with twenty tubes, 20 cm. C. R. D'E.

768. "*Electro-Catalytic*" *Igniter.* (Locomotion Automobile, 9. pp. 42–44, Jan. 16, 1902.)—A piece of platinum-iridium, or preferably osmium-iridium-ruthenium alloy, is mounted in a tubular metal socket which screws into the combustion chamber of the engine, like an ordinary electric sparking plug. The osmium alloy is heated by an electric current of about ½ watt, and the motor turned by hand in the usual manner for starting. The hydrocarbon vapour sucked in from the carburrettor then causes the igniter to glow brightly, and the ignitions commence. The electric current is then cut off, and the ignitions continue automatically until the engine is stopped by cutting off the mixture from the carburettor. The point of ignition can be varied by shifting the igniter within the tubular socket. This adjustment is easily effected by an external screw. The igniter is the invention of A. Wydts. C. R. D'E.

AUTOMOBILISM.[1]

769. *War Office Heavy Motor Vehicle Trials.* (Automotor Journal, 6. pp. 139–155, Jan., 1902.)—This article contains descriptions of the mechanical features of the five competing lorries, together with accounts of the performance of each vehicle throughout the trials. Detailed illustrations of the two Thornycroft steam vehicles and of the Milnes oil engine lorry are given, together with numerous photographs taken on the day of the cross-country runs. C. R. D'E.

770. *Fouillaron Light Car.* **L. Fournier.** (Locomotion Automobile, 9. pp. 22–24, Jan. 9, 1902.)—This car is constructed on the lines common to French light petrol cars. Its special feature consists of a variable speed belt transmission, employing expansible pullies, giving a **V**-shaped bed to the belt. The belt itself is constructed of leather blocks, which are arranged to adapt themselves to the varying inclination of the walls of the pulleys. The engine is of the single-cylinder vertical type, mounted near the front of the underframe. The variable-speed gear transmits from the countershaft to the differential shaft, and the final transmission to the road wheels are by chains. C. R. D'E.

771. *"Passe Partout" Motor Carriage.* (Locomotion Automobile, 9. pp. 38–40, Jan. 16, 1902.)—This is a light tricycle carriage, to seat two persons side by side, and partially collapsible for transport by rail. The frame is tubular, and carries towards its front end, which is built up to meet the steering pillar, a single cylinder petrol motor. The transmission is effected, first by a chain drive to a short-jointed shaft mounted on the steering pillar, and thence by chain to the front wheel, which is used for both steering and driving. A change-speed gear is mounted on an extension of the crankshaft, between the shaft and the pinion of the first chain drive. The body is carried by light plate springs. The vehicle can be folded into a space of 135 cm. long × 70 cm. wide, and weighs about 200 kilos. C. R. D'E.

772. *"Alcohol" Postal Vans.* **L. Périssé.** (Locomotion Automobile, 9. pp. 70–71, Jan. 30, 1902.)—The vehicle described consists of a light van body for postal work, mounted on a standard Pengeot underframe and gear, fitted with a two-cylinder horizontal engine, with cylinders 80 mm. × 108 mm., and developing 4 h.p. at 760 r.p.m. All four wheels of the vehicle are of equal diameter, and have pneumatic tyres. The total weight of the vehicle loaded is 1,250 kg., of which 500 kg. is useful load ; it is possible, on an emergency, to carry a load of 1,000 kg. Leprétre 50 per cent. alcohol is employed. Experience has shown that with this spirit a considerable deposit is formed in the tank and carburettor. The valves of the engine become quickly pitted, and require constant attention. From the results of many weeks' trial the consumption of alcohol works out at 0·140 lit. per tonne km., and with petrol 0·116 lit. per tonne km. C. R. D'E.

773. *Hafelfinger Motor Bicycle.* (Locomotion Automobile, 9. pp. 25–26, Jan. 9, 1902.)—In this bicycle, a single cylinder petrol motor is mounted on a diamond cycle frame of the ordinary type, except that the lower portion of the seat-post is formed of four tubes, between which is mounted the motor, with its crank chamber next to the bottom bracket. The crank-shaft is geared by spur wheel and pinion to a hollow shaft running on ball bearings in the bottom bracket. An equal ratio chain drive transmits from this shaft to the rear wheel of the machine. The pedal spindle runs through the hollow shaft, with which it engages by roller clutches which run free as soon as the engine starts. C. R. D'E.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

774. *Aeronautical Experiments.* **W. Wright.** (West. Soc. Engin., Journ. 6. pp. 489–510, Dec., 1901.)—This paper opens with a review of the work of Lilienthal, Pilcher, and Chanute with flying-machines of the aeroplane type, depending on gravity and wind for motive power. Balancing was one of the chief difficulties encountered by these experimenters. Balancing consists simply in causing the centre of pressure to coincide with the centre of gravity. It is very difficult in practice to make these centres coincident. In the machine mentioned above, balancing was effected by the operator shifting the position of his body during flight. The machine of W. and O. Wright is of the double-deck type, having two large cloth surfaces one above the other, attached to, and connected by, a light framework. These surfaces are slightly curved, and are approximately parallel, their width being several times greater than their depth in the direction of flight. The operator lies in a horizontal position, face downwards, on the longitudinal centre-line of the lower surface, his head being somewhat in advance of the front edge of the plane. The balancing and elevation of the machine are controlled by a third and smaller surface in advance of the machine, and so placed that the effect of the wind upon it counterbalances the pressure, due to passage through the air, on the main surfaces. This third surface can be curved up or down by the operator for steering. The lateral equilibrium and turning to right or left is effected by a torsion of the main surfaces. The machine used in experiments at Kitty Hawk, North Carolina, in 1900, had 165 square feet area. Used as a kite, it was supported with a man on it in a wind of about 25 m. per hour at an angle of 20°, this angle being much greater than had been calculated from Lilienthal's tables. Measuring the lift and drift of the machine, it was found that, while sustaining a weight of 52 lbs., the horizontal pull was only 8·5 lbs., which was about 50 per cent. less than the head resistance of Chanute's machine. Its deficiency in lifting power was attributed chiefly to insufficient curvature of the surfaces, this being only about 1 in 22, and to the fact that the cloth was not airtight. The control of the machine by means of the third surface proved entirely satisfactory. In the following year—1901—an almost identical machine was used, but the superficial area was increased to 308 square feet, and the curvature of the surfaces was 1 in 12. At first, certain difficulties were experienced in controlling this machine, but these were overcome by reducing the depth of curvature of the surface. Glides of over 300 feet at an angle of descent of 10 degrees were safely made. The fact that the surfaces were not perfectly airtight was found not to have any appreciable effect on the carrying capacity of the machine. The chief conclusions arrived at were: (*a*) That the Smeaton coefficient of $0{\cdot}0005V^2$ for the wind pressure at 90° is probably 20 per cent. too great; (*b*) that Lilienthal's estimate, that the pressure on a curved surface having an angle of incidence of 3° equals 0·545 of the pressure at 90°, is perhaps 50 per cent. too great; (*c*) that the superposition of surfaces somewhat reduces the lifting power per square foot. The paper is illustrated by photographs of the machines in flight. C. R. D'E.

GENERAL ELECTRICAL ENGINEERING.

775. *Wright Electrolytic Meter.* **J. R. Dick.** (Inst. Elect. Engin., Journ. 31. pp. 95–116, Dec., 1901.)—The author reviews briefly the earlier types of electrolytic meters; those depending on the deposition of mercury have the advantage of a very low back e.m.f., and of affording indications by volume instead of by weight. Difficulties are encountered in the deposition of crystals at the anode, variation in the resistance of the meter, and in contamination of the mercury. In Wright's meter a large vertical glass tube is closed below, and terminates above in a bulb. A trough is formed at the junction of tube and bulb, and contains the mercury which forms the anode. An auxiliary bulb containing mercury, and connected with the trough, acts like a bird fountain in maintaining the level of mercury in the trough. The kathode is a hollow cone of platinum or carbon, situated in the tube just below the mercury trough. By thus arranging the kathode below the anode, the formation of crystals is avoided, as the solution near the anode descends by gravity as soon as it becomes more concentrated. The meter is hermetically sealed, and is filled with a solution of mercurous nitrate. The mercury deposited in the kathode drops from it into a graduated tube, from the bottom of which rises an inverted U-tube; this acts as a syphon as soon as the graduated tube is filled, and the contents are emptied into a second graduated tube below. The syphon tube contains mercury representing 100 units, and each division in it represents one unit: the lower tube is graduated in hundreds of units, and corresponds to a second dial in an indicating train. The 5-ampere meter registers up to 12,000 units, and when a full record is obtained, the meter is reset by tilting it and allowing the mercury to flow back into the bulb. The meter is connected in shunt to a platinoid resistance in the main circuit. This has a value giving a drop of 1 volt on a 200-volt supply at full load. In series with the meter is a resistance partly of platinoid and partly of copper wire; the copper-wire resistance is adjusted to compensate for the negative temperature coefficient of the electrolyte. Tests made on the meter show that an accuracy of within 1 per cent. is easily obtained commercially, from very small currents to full current. The meter can be combined with a maximum demand indicator in such a way that the heating resistance of the latter forms the shunting resistance of the former, and the total drop of pressure is thus limited to 1 volt.

G. H. B.

776. *Electrical Equipment of Cranes.* **W. Rung.** (Elect. Rev. 49. pp. 411–412, Sept. 6; 499–500, Sept. 27; 621–622, Oct. 18; and pp. 903–905, Nov. 29, 1901.)—The direct-current series-wound motor is well suited for cranes. It has great starting torque, and starts smoothly; it lifts a heavy load slowly and a light one quickly; but it is unsuitable in cases where the load is liable to be very small, as the speed may then become so high as to be dangerous. The shunt motor is mainly used in cases where a constant speed is desired. The polyphase motor is as good as a direct-current motor; its starting torque can be made as great as that of a series-wound motor, and its speed can never exceed the normal. In any case the motor must start smoothly with a small amount of current, and must stop as quickly as possible when the current is switched off. It should therefore have a small amount of inertia, and run at a low speed. In the case of a 50-h.p. motor, running at 550 r.p.m., the armature weighed 500 kg., with a diameter of 36 cm.; another motor, also of 50 h.p., running at 200 r.p.m., had an armature weighing 800 kg., with a diameter of 56 cm. Upon calculating the moments of inertia it was found that the former required 2·9 times as much power at the start as the latter. As for three-phase motors, sizes up to 4 or 5 h.p. can be made with squirrel-cage rotors, and require no starting resistance, but they have relatively small starting torque, and start suddenly. Brown, Boveri & Co. build such motors with rotors of large electrical resistance; this increases the starting torque, and provides a smooth start. The brake action, caused by changing the motor into a generator, does not necessarily bring the armature to rest. If the braking is attempted after the speed has fallen below a certain limit, the e.m.f. of the motor may be so small as to cause no braking action, and in any case this method does not enable the load to be held in any position. Some form of mechanical friction brake is almost always added. An iron or copper disc rotated in a magnetic field will produce a braking action owing to eddy currents, but this action ceases as soon as the speed falls below a certain limit. The positions of the motors on the crane are then discussed, and a drawing is given showing the most suitable arrangement of motors and the wiring for a three-phase crane. The motor for working the crane longitudinally is best placed at the middle of one of the girders. The other motors should be carried by the crab. Any arrangement by which a motor is placed at the end of one of the girders is undesirable, although it shortens the electrical connections. Spur-wheel gearing is to be preferred to worm-wheel gears on the ground of efficiency. W. H. S

777. *Electric Feed-pumps.* **A. Johnston.** (Elect. Rev. 50. pp. 43–44, Jan. 10, 1902.)—The main problem in connection with electric feed-pumps is the regulation of the amount of water pumped into the boilers. One method is to close, or partially close, the check valves; the pump is run at constant speed, and is fitted with a relief valve, which is set to open at 20 or 25 per cent. above the working pressure of the boiler, the surplus water being returned to the hot well. Another method is to insert a resistance in series with the motor, which reduces the voltage across the motor terminals; the current will, however, be practically constant at all speeds. Neither of these methods can be regarded as economical. The best method is probably that using the series-parallel control, the motor armature having two separate and similar windings, each connected to a separate commutator. The author gives a list showing the various combinations possible, supposing the motor to be series-wound and the field to be divided into two equal sections. He is in favour of direct-coupled pumps without gearing, the pumps being smaller than usual, and the motors larger. In some correspondence which took place in the two succeeding issues of the Electrical Review, Mather and Platt state that they construct a feed-pump in which the delivery is controlled by varying the length of the stroke of the pump; and Merryweathers state that they construct a direct-connected pump, and give some figures which show the results obtained from one of their pumps erected in the Bristol electricity works. W. H. S.

REFERENCE.

778. *Electrical Drilling Machines.* (Engineer, 92. p. 634, Dec. 20, 1901.)—An illustrated description of several types of portable radial drills. H. R. C.

GENERATORS, MOTORS, AND TRANSFORMERS.

779. *A Three-phase Alternator.* **F. Winawer.** (Elekt. Runds. 19. pp. 86–87, Jan. 15, 1902.)—The article describes, with illustration, a new three-phase flywheel alternator, constructed by the Electrical Industry Company of Carlsruhe, wound for 4,000 volts, for coupling direct to a 760-h.p. engine running at 91 r.p.m. The armature ring is a massive cast-iron casting, which, when bolted up, is roughly triangular in cross-section. The diameter over the poles (66), which are bolted on to the rim of a double-armed flywheel, is 5·3 metres. The steam consumption of the set is given as 8·8 kg. per kw.-hour. E. K. S.

780. *Hunting of Paralleled Machines.* **A. Föppl.** (Elektrotechn. Zeitschr. 23. pp. 59–64, Jan. 23, 1902.)—Referring to Kapp's article on this subject [see Abstract No. 1085 (1899)], the author, while expressing himself in agreement with the general theory developed by Kapp, differs from him as regards the cause of the "hunting" or "phase-swinging." According to Kapp, this phenomenon is due to resonance effects between the driving torque of the engine and the natural oscillations of the alternator armature. The author points out that if such were the case, the oscillations would, according to a numerical example given by Kapp, be extremely rapid, while the period of the hunting of an alternator is relatively slow. The cause of the phenomenon is to be looked for in the behaviour of the governor of the engine, and this the author proceeds to investigate in detail, taking a Porter governor as the standard case. The conditions under which hunting of such a governor takes place are deduced from a simplified differential equation expressing the general relation between the various forces which act on the governor. Three cases are considered: (1) a single engine; (2) two engines rigidly coupled to the same shaft; (3) two engines connected to the same shaft through *elastic* couplings. The latter case corresponds precisely to engines driving paralleled alternators. The author deduces a formula by means of which the conditions under which no hunting can take place may be deduced, in terms of the constants of the governor and the torsional constant of the elastic couplings, and expresses a hope that an effort may be made to obtain an experimental verification of his theoretical deductions. A. H.

781. *Mechanical Slip Counter for Asynchronous Motors.* **E. Ziehl.** (Elektrotechn. Zeitschr. 22. pp. 1026–1028, Dec. 12, 1901.)—With the help of two coupled speed counters it is shown how the relative velocity between the rotor of a motor and the synchronous speed may be accurately found. The usual procedure will be to drive from the source of supply a small synchronous motor, and connect its axis, by means of a flexible coupling, to one of the counters, the other one being pressed into the centre of the shaft of the motor under experiment, when the slip per minute may be directly read off. The apparatus is made by the Berliner Maschinenbau-A-G. W. W. H. G.

782. *Discussion on Motors and Meters.* (Amer. Inst. Elect. Engin., Trans. 18. pp. 857–882, Dec., 1901.)—**Steinmetz,** referring to Browne's paper [see Abstract No. 2388 (1901)], considered that the consumers should pay some-

thing for the wattless current taken by their induction motors. Motors could be obtained taking small wattless currents at starting, but were more expensive; consumers would therefore purchase them only if their bills for current were diminished thereby. He mentioned a case where meters were made to register 25 per cent. of the wattless current by introducing self-induction into the shunt circuit. **Buck,** referring to Lincoln's synchronism indicator [see Abstact No. 1943 (1901)], pointed out that the need of an accurate apparatus of this description was increasing, for, with the large direct-coupled alternators now coming into use, the power required to synchronise the machine is very large. **Mershon** and **Scott** pointed out that an induction motor takes an excessive wattless current at starting, only if it has a short-circuited rotor; if provided with slip-rings and an adjustable resistance it will compare favourably with a direct-current motor. **Mailloux** mentioned a case where a 40-h.p. induction motor took so much wattless current at starting as to frequently blow the fuse of a 150-kw. machine; he considered that a consumer using motors of this description should be penalised by a charge for wattless current. **Dunn** showed curves of 5-h.p. shunt and compound direct-current motors and an induction motor. From these he concludes that the induction motor takes 10 per cent. more power at full load, and twice as much starting current for the same torque. At partial loads the efficiencies are about the same, but at full load that of the induction motor is some 8 per cent. less. The increase in speed between full and no-load is 4½ per cent. for the shunt, 6 per cent. for the induction, and 7½ per cent. for the compound motor. The maximum torque which can be obtained from the induction motor is 2·7 times the normal, from the shunt motor 6·4 times, and from the compound 10·8 times the normal torque. G. H. B.

783. *Alternate-current Motors and Rotary Converters.* **C. F. Scott.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 883–894, Dec., 1901.)—The author enumerates the characteristics of synchronous and induction motors in parallel columns. The comparison shows that the former is not suitable for general distribution of power, owing chiefly to its lack of starting torque, the skill required in attendance, and its liability to stop if the conditions become abnormal. These objections are less important when motors are installed in substations or are of sufficient size to justify an attendant; and the synchronous motor possesses the advantage of giving a means of bringing the power-factor of the circuit to unity. The rotary converter is essentially a synchronous motor, and is subject to many of its defects. The starting, however, is simpler, and no exciter is required. The author compares the rotary converter with an induction motor generator; wherever the generators are subject to fluctuations in speed, the latter are preferable. G. H. B.

784. *Geometrical Study of the Alternating-Current Transformer.* **Brunhes.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 399–447, Nov.–Dec., 1901.)—Problems in connection with the alternating-current transformer are solved geometrically. Instead of starting with the assumption that the applied p.d. is constant, the author supposes that the resultant of the magnetising forces is constant. He then constructs a diagram showing how the pressures can vary subject to this restriction. From this diagram the values of the magnetising forces when the applied pressure is constant can be found by constructing inverse curves. The geometrical properties of these inverse curves are fully discussed and the results applied to solve transformer problems, taking hysteresis, eddy currents, and inductive loads into account. A. R.

785. *Cooling of Transformers.* **W. S. Sessions.** (Journal of Electricity, S.F., 11. pp. 264–265, Nov., 1901.)—It was found at the power station of the Mount Whitney Power Company [see Abstract No. 375 (1900)] that the 500-kw. transformers used to raise the generation voltage from 440 to 17,300, although built with a large radiating surface, and air cooled, became overheated in the summer. The oil in the transformers was therefore pumped through long coils of iron pipe placed in the tail race, and then returned to the transformers. The pump was started on June 3, 1901, stopped from the 9th to the 14th, and then kept running continuously. The results are given in the following table ;—

A COMPARISON OF AIR AND TRANSFORMER TEMPERATURES.

(Readings taken daily at 6 p.m.)

Day of Month.	Month of May. Temp. deg. Fahr.		Month of June. Temp. deg. Fahr.		Month of July. Temp deg. Fahr.		Month of Aug. Temp. deg. Fahr.	
	Air.	Oil.	Air.	Oil.	Air.	Oil.	Air.	Oil.
1	76°	115°	94°	130°	100°	86°	106°	104°
2	76	108	89	121	98	90	105	105
3	80	117	88	84	91	88	100	107
4	84	117	85	76	95	97	95	108
5	85	117	90	76	104	97	98	115
6	88	122	91	83	107	90	102	116
7	88	124	91	83	101	88	104	116
8	90	126	84	76	99	90	103	116
9	90	125	83	112	100	90	105	117
10	93	126	82	118	104	90	106	117
11	87	113	85	120	104	92	104	108
12	89	121	82	118	103	92	108	109
13	89	121	81	117	98	90	102	109
14	90	124	88	122	96	88	100	108
15	90	124	95	77	98	90	99	109
16	92	126	95	84	95	94	102	109
17	88	122	96	88	100	94	103	109
18	80	118	92	84	102	95	99	109
19	73	115	85	81	105	95	97	112
20	80	110	92	82	106	97	99	112
21	77	112	98	84	96	97	96	113
22	83	117	99	88	102	97	93	112
23	75	110	89	83	102	96	93	103
24	70	110	85	84	104	99	92	110
25	68	106	85	84	106	100	96	95
26	80	108	92	84	108	101	98	109
27	78	112	99	88	106	101	98	110
28	79	111	105	88	104	100	97	108
29	87	118	109	88	97	102	97	106
30	85	121	103	86	98	102	95	106
31	93	124	...	...	106	106	93	105

The variation in the temperature difference between the oil and the transformer when the pump was running is partly due to change in the water temperature with the season, but mostly to variation in the load, which was extremely heavy during August. G. W. DE T.

786. *Core Transformers of Maximum Efficiency.* **F. Punga.** (Zeitschr. Elektrotechn., Wien, 19. pp. 609–614, Dec. 15, and pp. 624–625, Dec. 22, 1901.)—The author considers in detail the following two problems: (1) Given the complete specification of a transformer, to determine the dimensions of the core corresponding to minimum cost of materials; (2) given the cost, to construct the transformer so as to satisfy the condition of maximum efficiency. In either case the author supposes the core to be □-shaped, with cylindrical coils on the vertical limbs of the core, the cross-section of which is assumed to be a square. The method of solution consists in assuming that the length of core and depth of winding are made to undergo a small change, and investigating how this change affects total cost in the first case, and efficiency in the second. The results obtained involve the relative cost of copper and iron, and the ratio of the actual cross-section of copper to the total cross-section of the coil. The author gives a number of curves embodying the results of his calculations. A. H.

787. *Rotary Converters.* **A. S. M'Allister.** (Amer. Electn. 13. pp. 568–570, Dec., 1901.)—This paper is a *résumé* of the principles of construction and working of rotaries. The following are some of the points discussed:—Speeds and frequencies; the ratio between the direct and alternating voltages for different ways of connecting; wave-form; field excitation; pendulum motion of armature; methods of starting and synchronising. The advantages of rotaries over direct-current generators are insisted on, and the causes explained; absence of field distortion and increased output in the rotary due to diminution of effective armature resistance being specially alluded to. In connection with this latter point, the author urges the desirability of using six-phase rotaries, from which a much greater output can be obtained than from three-phasers; the six-phase current can be obtained from an ordinary three-phase supply, the connections being in reality not at all complicated. The paper concludes with a discussion of the "inverted" use of rotaries, as operated to convert from direct to alternating current. B. P. S.

788. *Transformers in Parallel.* **A. G. Hansard.** (Electrical Times, 21. pp. 86–87, Jan. 16, 1902.)—A simple explanation is given of the parallel working of the alternating-current transformer. To insure good parallel working it is not sufficient to specify that the transformers have the same transformation ratio and the same drop from no-load to full load. The author points out the importance of measuring the "short-circuit volts" of a transformer, which can easily be done by short-circuiting one winding through an ammeter, and applying to the other winding a p.d. that will cause the full-load current to be read on the ammeter. If transformers of different designs are to be run in parallel it is absolutely necessary to specify the "short-circuit volts." A. R.

789. *Hulin and Leblanc's Improved Rectifier.* **A. Vincent.** (Écl. Électr. 30. pp. 29–38, Jan. 4, 1902.)—This is the first instalment of a paper descriptive of the new type of "Panchahuteur" [see Abstract No. 356 (1900)], in which the primary of the transformer creates a revolving field, which produces an e.m.f. in the successive windings of the secondary, of which the values vary from coil to coil exactly like the pressures in successive armature coils of an ordinary bipolar dynamo. As in the former type of "panchahuteur," connections are brought out from each secondary to the bars of a fixed commutator, round which the brushes are rotated in synchronism with the speed of the revolving field. A description is given, illustrated by wood blocks and photographs, of the fixed transformer, and of the brush motor. A special feature of the former is the system of compensating coils adopted to ensure that the revolving field should have a constant strength and a sinusoidal distribution around the ring. It is shown mathematically that the number of turns in these compensating coils (of which there are two sets, a primary and secondary) should vary from coil to coil according to the sine law. In the mathematical treatment of the subject, an alternating flux is looked upon as the resultant of two constant fluxes rotating in opposite directions at a uniform speed. If, then, the primary of the transformer be supplied with a monophase alternating current, one of the rotary fluxes which may be considered to be generated thereby—that, namely, which turns in the same direction as the brushes—constitutes the useful field; the other is a harmful field, which would produce in the coil, which at any instant is short-circuited by the brush, an electromotive force which would waste energy and produce sparking; and this flux must be neutralised if commutation is to be perfect. In the case of a transformer supplied with a system of polyphase currents, producing a single rotary field, the system of compensating coils by ensuring a harmonic distribution of the main flux reduces the harmless fluxes to a negligible point. B. P. S.

790. *Hutin and Leblanc's Improved Rectifier.* **A. Vincent.** (Écl. Électr. 30. pp. 55–61, Jan. 11, 1902.)—This is a continuation of a former paper [see preceding Abstract]. The author now discusses the action of his machine when transforming from direct to alternating current; the first case considered is from low-tension direct to high-tension polyphase. The fields of the brush motor are first excited, and the machine started up by a hand-gear, which is automatically disconnected when the proper speed is attained. At the same time the brushes are pressed against the collector by the action of centrifugal force. Continuous current is then sent through the thick-wire winding of the transformer, being regulated by a starting resistance. A rotary magnetic field is thus produced in the transformer, revolving with the same speed and in the same direction as the brushes. The author proceeds to explain the effect of the "compensating coils" in making the flux truly sinoidal. The final result in the rotating armature being a flux fixed in space, there can be drawn from its windings an alternating current of any desired number of phases, depending on the number and positions of the points where the armature winding is tapped. The frequency of the two- or three-phased currents drawn from the armature depends on the speed of the motor, and this can be regulated with great nicety by controlling the pressure at the direct-current terminals. As in an ordinary direct-current motor, the lead of the brushes for good commutation must vary with the load; this is effected in the present case, not by any adjustment of the revolving brushes, which would be a difficult matter, but by rotating the fields of the brush motor through the desired angle by a mechanism provided for the purpose. In the special case where single-phase current is drawn from the armature by tapping at the extremities of a diameter, the inventor finds it necessary to make use of a small auxiliary two-phase motor, provided with an "amortisseur," which is connected in circuit with the "resultant circuits" of the transformer, with which it runs synchronously. This has the effect of neutralising the harmful component of the revolving magnetic field referred to in the former part of the paper. This auxiliary motor is mechanically quite independent of the transformer, and can be fixed in any convenient position.

In addition to the function alluded to, it plays another important part, similar to that performed by a flywheel in the analogous case of the mechanical conversion of a periodic straight line movement into uniform circular motion; the input of energy into the transformer (in the shape of continuous current) being uniform, and the output, when in the form of *single-phase* alternating current, essentially oscillatory, the motor stores up and restores to the circuit at the right instant the energy which would otherwise be used very inefficiently.

The paper concludes with a description of some very successful tests made on the machine operating in various ways, and with a summary of its advantages and uses. These may be thus stated: (*a*) If supplied exclusively with direct current at low tension, the machine can supply, *at the same time*, mechanical energy available at the motor pulley, and electrical energy, under the form of high-tension alternating current. (*b*) Conversely, if supplied with high-tension alternating current, both mechanical energy and low-tension continuous current can be obtained from it simultaneously. (*c*) If only mechanical energy is required, the machine can be supplied with low-tension continuous current and high-tension alternating at the same time. (*d*) If the machine is fed with "resultant currents" drawn from the motor acting as generator, it becomes a two-current generator, and can furnish at will, or simultaneously, low-tension direct current and high-tension alternating. Points worthy of notice are: that the commutation is perfect at all loads, and that the output is therefore limited simply by the heating of the coils; and that owing to the suppression of all the more important harmonics (in the machine described the fifty-ninth harmonic is the first which is allowed to develope) the wave form of the alternating current produced is practically a perfect sine-curve. B. P. S.

REFERENCE.

791. *Rotary Converters.* **G. W. Colles.** (Frank. Inst., Journ. 151. pp. 207–235; 263–282; 341–368; 429–445; and 152. pp. 12–26, 1901.)—This series of articles gives a very exhaustive and up-to-date account of the various forms of apparatus which have been devised for the purpose of transforming one form of electric current into another, and which contain rotating parts. The historical aspect of the problem of transformation is very fully dealt with, and the articles are fully illustrated.

A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

792. *Effect of Bending of Poles on the Tension of a Broken Line.* **Colard.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 338–349 ; Discussion, pp. 349–350, Aug., Sept., and Oct., 1901.)—If a breakage occurs in an aerial line, the bending of the poles will give rise to an increased sag, and corresponding diminution of tension, which increases as the broken section is approached. The author confines his attention to cases in which the sag is small enough to permit of the identification of the curve assumed by the wire with the ordinary parabola. In a former paper (La Lumière Electrique, 52. p. 557, June 23, 1894), he gave an analytical method of solving the problems arising, by means of expansions in series. The series obtained were not, however, convenient for calculation, and in the present paper he sets forth a graphical trial and error method which he finds simple and easily applicable in practice. The most important problem is to so determine the strength of the poles as to ensure their withstanding the greatest lateral pull to which they may be subjected by the breaking of the line, while avoiding the unnecessarily high cost which would be involved if provision were made against a lateral pull equal to the tension of the unbroken line. G. W. de T.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

793. *The Boston, U.S.A., Subway and the Rapid Transit Subway, New York.* (London County Council Report, No. 555, pp. 3–19, Nov. 7, 1901 ; also Tram. Rly. World, 10. pp. 709–712, Dec., 1901. Abstract.)—Both these schemes were entered upon on the reports and suggestions of Commissions appointed by the local authorities in the respective towns ; in the case of Boston the Commissioners visited, as a preliminary step, numerous European cities for the purpose of comparing the various methods adopted for the relief of street traffic congestion. The Boston tramway will, when complete, be equivalent to 5 miles of single track, part being laid with four tracks and part with two. That portion now completed is 1,300 yards in length, and commences with an incline 100 yards in length, carrying the surface lines underground. In streets where ample space existed the method of open excavation was adopted, tunneling proper being resorted to for one or two short lengths where cut-and-cover methods were not practicable. There are three distinct types of subway : (1) the side walls and arch are of masonry ; (2) two distinct masonry tunnels, side by side ; (3) transverse steel girders and jack arching to form the roof, supported by side walls composed of steel columns interspersed with masonry or concrete. The open inclines leading to the tunnel have granite walls, and are protected by railings. The standard height of the roof is 14 feet clear above the surface of the rails, and the roof is generally about 3 feet below the street surface. Lifts are thus unnecessary, approach to stations being gained by a short, well-lighted stairway. The island principle has been adhered to in the platforms and separate entrances and exits provided. Glazed brick lining is used only near the stations, the remaining lengths being simply whitewashed. Both the overhead trolley and third-rail systems are employed. The tunnel is lighted throughout by incandescent lamps, although a considerable amount of natural light is obtained. The number of cars running in each direction is 250 per hour, the passenger traffic at the busiest station being stated at 27,400,000 per annum. In the opinion of the L.C.C. Commission the effect of the subway upon the street traffic has been very considerable.

New York.—The subway here is at present under construction, and will consist of a total length of 21 miles, seven of which are to be laid with four tracks and 14 miles with double tracks. Cut-and-cover methods are adopted, the covered way being rectangular in shape and built in open trench. Transverse steel frames, supported on concrete bottoms, are placed at 5-feet intervals with concrete walls and roof, the concrete enclosing the steel entirely. Light steel columns between the tracks afford a further support to the roof. The two centre tracks will be used for an express service, designed for a speed of 30 miles an hour, with stations 1½ miles apart. On the outer tracks 14 miles an hour is the designed speed, with stations at more frequent intervals. Crossings and switches are reduced to a minimum by lowering one track under the other. The work will be completed in 1904.

The L.C.C. Commission favour the plan of shallow underground tramways for London as a means of (1) linking up existing tramways by taking surface cars through congested and prohibited areas, (2) affording provision for pipes, cable wires, &c., thus obviating the continual breaking up of the streets.
C. E. A.

794. *Truckee River Electric Power Plant.* (Eng. Record, 44. pp. 562–563, Dec. 14, 1901.)—This paper contains a description of a water-power station, transmitting power by three-phase current over a distance of 30 miles to the Comstock silver mines in California. W. H. S.

795. *Power Station at Ludlow, Mass.* (Eng. Record, 44. pp. 610–613, Dec. 28, 1901.)—The Ludlow Manufacturing Company has built a water-power station at Red Bridge, on the Chicopee River, where 5,000 h.p. is generated and transmitted by three-phase current over a distance of four miles to the Company's hemp and jute factories. The article is mainly concerned with a description of the hydraulic work. W. H. S.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

796. *Polyphase Currents for Traction Work.* **I. Galmozzi.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 351–396, Aug., Sept., and Oct., 1901.)—In this paper the author developes, simply and systematically, the systems of equations applicable to the case of a trolley line supplied with either two-phase or three-phase currents. A numerical example of a three-phase system is worked out in detail. The author advocates a two-phase in preference to a three-phase system, mainly on account of its greater economy, resulting from the fact that for a given frequency and a given amount of power delivered to the motors the current in the trolley wires will be less, and that in the rails greater, in a two-phase then in a three-phase system, with a consequent saving in C^2R losses, owing to the very much higher conductivity of the rails as compared with the trolley wires. He shows that under the conditions ruling in practice the additional lag due to the permeability of the rails is not sufficient to cause serious inconvenience. G. W. de T.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

797. *A High-Speed Railway Car.* **O. Lasche.** (Inst. Elect. Engin., Journ. 31. pp. 24–66 ; Discussion, pp. 66–76, Dec., 1901.)—This car has been arrived at after protracted experimental investigation resulting in numerous modifications, by the Allgemeine Electricitäts Gesellschaft, working in co-operation with the German "Association for the Study of Electrical High-Speed Railways," and will be tried on the military line from Berlin to Zossen, at speeds varying up to a maximum, as at present intended, of 200 kilometres (124 miles) an hour. The power will be supplied from the Oberspree Central Station, 15 kilometres (9·3 miles) from the nearest point of the line, with three-phase current at 50 ∿ , and a voltage of from 10,000 to 12,000. The voltage will be reduced to 435 by the transformers in the car. About 50,000 is regarded as a suitable voltage for main railway lines, and the author suggests the possibility of its being found advisable to transform this down to 3,000 at substations along the line, winding the motors for the latter voltage, and so eliminating the heavy weight of the transformers from the car equipment. Transformation to continuous current he regards as impracticable for long-distance railways, as it would involve the use of rotary transformers, at very short intervals on account of the low voltage limits, with attendance at all substations. The inconvenience of the three trolley wires for points and crossings might require the use of a slow-speed continuous-current locomotive to take cars over sections traversing large towns.

Car Body.—The car is 21 m. (69 ft.) long by 2·6 m. (8 ft. 6 in.) broad, with a distance of 23·1 m. (72½ ft.) between the buffer plates, and carries 50 passengers. The windows are closed, ventilation being effected by means of the side windows of the skylights. The apparatus is in the centre of the car, and this portion, as well as the driver's platform, has grated doors to exclude the passengers, who can, however, pass from one compartment to the other. No live conductors are accessible to either driver or passengers. The front of the car is slightly curved, but the best shape is left for experimental determination by the addition of various shaped screens during the trials. *Bogies.*—The two bogies are 13·3 m. (43 ft. 7 in.) apart, each having three axles, of which the two outer ones carry the motors; the middle one having no motor, space is left for the pivot and the Westinghouse brake cylinders. The diameter of the wheels is 1,250 mm. (49·2 in.), and the distance between them is 3,800 mm. (12 ft. 6 in.). There are no springs bearing against the body of the car, but the bogies themselves are supported on the axles by two sets of springs ; and each axle-box carries a strong plate spring, to the head of which are attached supporting springs carrying the frame. *Current Collection.*—The trolleys are of the bow type, three at each end of the car, each trolley being carried on a separate arm. In order to avoid any material change of distance from the trolley wires when passing curves, the distances between the arms are only just sufficient to allow of the bows turning about the vertical axes. To ensure good and continuous contact at high speed without large contact surface, each bow is formed of a number of aluminium contact rods carried by plate springs of different lengths. The head of the arm carrying the bow is pressed out of aluminium sheet, and is connected to the vertical base by rods, the base being mounted on ball bearings in the socket on the car. The bow is pressed against the trolley wire by springs, the tension of which is regulated by cams. All high-pressure conductors were tested to 20,000 volts, and in addition are mounted on high-pressure insulators. Safety fuses are fixed close to each bow, and the leads pass from them to a high-pressure switch to cut off current at the termini, but which will not be used while running, unless in case of failure of the controller switches through any accident. Fuses are inserted between the high-pressure switch and the transformers. *Transformers.*—The secondary consists of a massive copper spiral, separated from the primary by a micanite cylinder. The axes of the cores are placed longitudinally in the car, and a cooling air current entering through the roof is first filtered, and then flows through longitudinal channels provided in the interior of the cores, but does not come in contact with live conductors. The cores are supported at their centres to prevent deformation from vibration, and the transformers are suspended from the body of the car by means of draw bolts. *Motors.*—Each of the four motors has a normal output of 250 h.p., but is capable of a maximum of 750 h.p. The speed is about 960 r.p.m, corresponding to a car-speed of 225 km. (140 miles) an hour. To ensure permanent safety in working there is only one bar in each groove, the insulation being of closed micanite tubing. The low voltage of 435 was adopted to enable a bifurcated winding to be used, and this is employed for both stator and rotor. For convenience in the arrangement of the starting apparatus and leads, the rotor is wound for only two phases. The stator, by means of two bearings, carries a hollow shaft on which the rotor is built up, and the upper half of one of these carries the brush holders, with the connections between the rotor circuit and the controller. Through the other bearing pass the stator circuit cables. Access to the brush gear is obtained by removing the lower halves of the bearings and taking out the brasses. The motors are supported by strong springs bearing against the axle box. By means of an adjustable curved block the flexure is made easy for the first few millimetres, with a gradually increasing stiffness to a maximum deflection of 8–10 mm. The motors are screwed to iron frames supported by ordinary car springs, and lateral motion is prevented by abutments bearing against slides. The stator is prevented from turning by bars which only allow of a vertical movement. The coupling is effected by means of a ring in three parts mounted at each end of the hollow shaft, double arms formed of bundles of springs being fitted in each part, the ends of the springs bearing against guide-pieces attached to the wheel. Lubrication under pressure would lead to cumbersome pipe connections, and therefore, oiling rings being unsuitable for railway work, a smooth disc of large diameter mounted concentrically on the axle, and dipping 30–40 mm. into an oil bath is employed. The bearings are of white metal, and the hollow shaft is of nickel steel. The radial distance between the latter and the axle is 30 mm. Copper rings are forced into the ends of the hollow shaft, and lateral motion of the latter is prevented by means of a guide against one bearing only, to avoid the possibility of binding when heated. The springs are secured in the annular pieces by wedges in such a manner that the centrifugal pressure increases that of the wedges. The plates are prevented from flying out by lateral extensions within the hub. The hub portions are of forged steel, and the power is transmitted by means of keys from the hollow shaft to the three-part hub of the coupling. *Controller.*—This consists of an adjustable liquid resistance, in which a small centrifugal pump, driven by an electro motor, raises the liquid from a reservoir into the resistance vessel, the resistance diminishing as the level of the liquid rises. The liquid returns to the reservoir through a number of serpentine copper tubes of small diameter in order to cool it before returning it into use. A constant circulation is maintained, so that any suitable large resistance may be brought permanently into the circuit, and the speed thereby slowed down to any extent required. An adjustable valve regulates the speed of delivery, and any desired maximum may be fixed for this, so that the driver cannot accelerate beyond a determined rate, while retaining full control up to this limit. The power required being very small, this device can be operated from the driving platform by means of a hand-wheel and connecting shaft. *Brakes.*—A Westinghouse compressed-air brake is employed, together with two electrical methods : (1) After the rotor circuit is broken by opening the outlet valve of the liquid controller, the field circuit is, by means of a change-over switch, first broken, and then switched on to a storage battery ; (2) two of the phases bringing current to the motor are interchanged, producing a torque tending to reverse the rotation of the rotor. It is intended to employ the motor braking exclusively when running, and only to employ the air brake at the termini. [Presumably also in the case of emergencies.] The paper gives an interesting account of the experimental evolution of the designs adopted, and is copiously illustrated.

G. W. DE T.

798. *System of Rail-Joints.* (Tram. Rly. World, 10. pp. 624–625, Nov. 1901.)—This system is in use at Linz on the Danube, where it is employed on the electric street and mountain railway. The rail-coupling is constructed without screws, on the well-known wedge principle, and grasps the base of the rail at the joint, for which reason it has been designated the "rail shoe." It can be used either alone or in combination with a fish-joint, and with its use it is impossible for either rail end to be depressed, the unpleasant jolting which is so injurious to the rail-ends being thus eliminated. The joint can be put down by four men with the aid of very few tools and a portable blast-furnace. Both the placing and moving can be effected with ease. It makes a reliable electrical contact, although it is not as yet recommended that the usual copper contact-pieces be dispensed with. Besides having the advantage of a low price, it is claimed that its cost is less than one-half of that involved in casting round or welding the rail. The joints form strong supports, owing to their broad bases, increasing the stability of the whole line. Explanatory diagrams are given.

C. E. A.

ELECTRIC LAMPS AND LIGHTING.

799. *Vapour Lamps.* **P. C. Hewitt.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 935–941, Dec., 1901.)—The author has made lamps giving from 10 to 3,000 candles, with efficiencies as high as ½ watt per spherical c.p. The mercury vapour lamp gives a light deficient in red rays ; lamps have been made giving a redder light, but at the sacrifice of efficiency. The resistance of the lamp varies inversely as the diameter of the tube, and inversely as the current. When the vapour density is increased the resistance diminishes to a minimum and then increases with the density. When current begins to pass through the lamp the resistance diminishes rapidly. The high initial resistance occurs at the negative electrode, and is diminished by positively charging the surface of the lamp exterior to the negative electrode. It is overcome by a discharge of high potential. [See also Abstract No. 622 (1902).]

G. H. B.

REFERENCE.

800. *Street Illumination.* **W. d'A. Ryan.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 909–921, Dec., 1901.)—This paper covers similar ground to that of Abstract No. 257 (1902).

C. K. F.

TELEGRAPHY AND TELEPHONY.

801. *Wireless Telegraphy.* **Ferrié.** (Soc. Int. Élect., Bull. 2. pp. 9–49, Jan.; Discussion, pp. 85–103, Feb., 1902.)—This paper deals historically with the progress of wireless telegraphy since the year 1900, when a joint report by the author and Blondel was presented to the International Congress of Electricians [see Abstract No. 477 (1901)]. At the conclusion of the historical sketch the author observes that wireless telegraphy is still subject to two serious drawbacks: (1) The complexity, cost, and delicacy of the apparatus required; (2) insecurity of communication. The latter is the more important, and is not remedied by syntonising. Transmission of messages between two points can be made impossible by operations carried on with that intent at a station between them; and, again, communication is often interrupted by atmospheric disturbances. The author commits himself to the prophecy that the telegraphic efficiency will always be low on account of disturbing causes and of slowness of transmission, both of which defects he considers to be inherent. For this reason, and on account of the increasing difficulties to be apprehended from interference between different stations as the use of wireless telegraphy extends, the author considers that its usefulness will be mainly restricted to naval purposes, though it may possibly find use in special cases in the mercantile marine and in military operations.

Discussion.—**G. Claude** spoke at length in favour of the theory that the action of the antennæ depended mainly on their electrostatic capacity relatively to the earth and to each other. The author of the paper, in his reply, showed that this theory, which had been put forward by Anderson in 1898, was inconsistent with numerous well-ascertained results of observation. G. W. de T.

802. *Overhead Insulators for Telephones and Telegraphs.* **E. Piérard.** (Soc. Belge Élect., Bull. 18. pp. 263–267; Discussion, pp. 267–269, July, 1901.) —Dimensioned drawings of the porcelain insulators used by the Belgium Administration are given. Where malicious damage is feared, the outer surface is not glazed, and a steel hood is cemented to the insulator with plaster of Paris. Telegraph insulators are made in two standard sizes (dimensioned diagrams given), the edges of the lips and the groove in the head being unglazed. M. O'G.

REFERENCES.

803. *Wireless Telegraph Patents.* **A. Turpain.** (Écl. Électr. 29. pp. 77–93, Oct. 19, 1901.)—This is a paper containing descriptions of a number of recent wireless telegraph patents by various inventors. G. W. de T.

804. *Telephony without Wires.* **E. Ducretet.** (Comptes Rendus, 134, pp. 92–93, Jan. 13, 1902.)—An account is given of some successful telephonic experiments made with the earth as the only conductor. J. J. S.